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ECONOMIC ANALYSIS OF EFFLUENT GUIDELINES FERROALLOYS INDUSTRY

A. T. KEARNEY, INCORPORATED

PREPARED FOR
ENVIRONMENTAL PROTECTION AGENCY

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The report summarizes the economic impact of water pollution abatement on selected segments (Ferromaganese, Ferrosilicon, Ferrocrome, & Silicanmagenese) of the ferroalloys industry. Discussed are the industry structure, financial profile, sources of water pollution, projected costs and price increases, and the effects on production, plant closings, and local communities.

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JUNE, 1974

OFFICE OF PLANNING AND EVALUATION
ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D. C. 20460

CONTRACT NO. 68-01-1545

PREFACE

The attached document is a contractor's study prepared with the supervision and review of the Office of Planning and Evaluation of the U.S. Environmental Protection Agency (EPA). Its purpose is to provide a basis for evaluating the potential economic impact of effluent limitations guidelines and standards of performance established by EPA pursuant to sections 304(b) and 306 of the Federal Water Pollution Control Act.

The study supplements an EPA technical "Development Document" issued in conjunction with the promulgation of guidelines and standards for point sources within this industry category. The Development Document surveys existing and potential waste treatment and control methods and technologies within this category and presents the investment and operating costs associated with various control technologies. This study supplements that analysis by estimating the broader economic effects (including product price increases, continued viability of affected plants, employment, industry growth and foreign trade) of the required application of certain of these control technologies.

This study has been submitted in fulfillment of Contract No. 68-01-1545, by A. T. Kearney, Inc. Work was completed as of June, 1974. The study is based primarily upon an earlier study, also prepared by A. T. Kearney, Inc. entitled "Economic Analysis of Proposed Effluent Guidelines for Ferroalloys Industry." The earlier report was circulated in conjunction with the publication of the Federal Register of a notice of proposed rulemaking under sections 304(b) and 306 for the subject point source category. The analysis contained in the original study has been updated based upon information received during the period of time between publication of the notice of proposed rulemaking and the promulgation of the final regulation. Because of the constraints of time, the control and treatment costs analyzed in this study may not in all instances be identical to those associated with the requirements of the promulgated regulation. However, those differences, when they exist, are minor insofar as the final conclusions of the study are concerned.

This report represents the conclusions of the contractor. It has been reviewed by the Office of Planning and Evaluation and approved for publication. Approval does not signify that the contents necessarily reflect the views of the Environmental Protection Agency. The study has been considered, together with the Development Document, information received in the form of public comments on the proposed regulation, and other materials in the establishment of final effluent limitations guidelines and standards of performance.

ENVIRONMENTAL PROTECTION AGENCY

ECONOMIC ANALYSIS OF EFFLUENT GUIDELINES FERROALLOYS INDUSTRY

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ENVIRONMENTAL PROTECTION AGENCY

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EXECUTIVE SUMMARY

INTRODUCTION

It was the objective of this study to determine the impact of the costs of water pollution abatement on the Ferroalloys Industry. The study was restricted in scope to an analysis of the four major ferroalloys: FeMn, FeSi, FeCr, and SiMn. The scope was also limited to products which are produced in electric furnaces. This limited scope represents about 85% of the Industry's annual production.

We would like to acknowledge the participation of J. E. Allen & Associates in the technical aspects of this study, as well as the cooperation of the Ferroalloys Association and the Bureau of Mines in the supply of data and information relevant to the study.

THE INDUSTRY

(a) Ferroalloys Production

Industry shipments of all types of ferroalloys totaled over 2.8 million short tons of gross weight in 1973, with a value of $729 million. The total industry has shown little growth in the past decade. In the period 1967 to 1972, shipments fluctuated between 2.3 and 2.6 million short tons of gross weight. The increased shipments in 1973 reflected the increase in total tons of raw steel production in that year.

Table 1

Shipments of Ferroalloys
(Short tons, Gross weight)

Year	Tons Shipped (MM)
1967	2.5
1968	2.4
1969	2.6
1970	2.5
1971	2.3
1972	2.4
1973	2.8

Sources: 1971 Minerals Yearbook
1972 Minerals Yearbook, Preprint
1973 Bureau of Mines, Preliminary Draft

The four ferroalloys specifically studied have shown a similar pattern of production. This is seen in Table 2.

Table 2

U.S. Consumption and Production of Noncaptive FeMn, FeSi, FeCr and SiMn, 1967-1973
(Tons of Contained Element)

Year	U.S. Consumption (000)	U.S. Production (000)
1967	999	756
1968	1,061	838
1969	1,109	800
1970	1,015	745
1971	972	697
1972 (P)	1,039	626
1973 (P)	1,266	773

Note: P = Preliminary Data

Source: Exhibits II-6 and II-12

Industry consumption of ferroalloys per ton of steel produced has remained at a relatively constant level. Production of selected ferroalloys in the United States has been declining in the face of increasing imports, particularly FeMn and FeCr. Industry shipments of these four ferroalloys were estimated to be valued at $425 million in 1972 and $535 million in 1973.

The primary markets for ferroalloys are the Iron and Steel Industry, annually accounting for approximately 90% of the product tonnage and 70% of the dollar volume. Consumption of ferroalloys in the United States can be expected to follow trends in domestic production of raw steel. Future U.S. production of ferroalloys will be subject to the impact of imported ferroalloys.

(b) Industry Manufacturers

There are only nine companies, operating 22 plants, each currently producing at least one of the four major ferroalloys. These firms range in size from about $20 million to over $3 billion in total annual sales. The diversity of products manufactured by these companies ranges widely. Some companies are highly specialized, producing only ferroalloys, while, for others, ferroalloy shipments represent less than 5% of total annual sales.

The four largest of the 22 plants account for more than 45% of the combined capacity, while the ten largest account for more than 75% of the total capacity of all 22 plants.

(c) Status of the Industry

The Ferroalloys Industry is presently operating at capacity due to the current high level of steel production. In 1972, the Industry's shipments and profitability were severely affected by modest first quarter steel production and the high level of imported ferroalloys throughout the year. The resurgence of steel demand in 1973 improved production and profitability. A weighted average of the percent after-tax margin on sales for seven of the nine firms was 5.7% in 1973. This is slightly better than the 5.6% after-tax margin reported in 1973 for 2,136 manufacturing firms and 35% better than 66 iron and steel firms.* However, the profitability of this industry, when measured as a percent return on equity, is only 13.4% compared with 14.8% for the FNCB sample of 2,136 representative manufacturing firms.

Air pollution control requirements now under development are of major concern to the industry. Air pollution control costs and imports are expected to have a greater impact on the industry than the anticipated costs of water pollution abatement, which were felt to be minor. Based on this and a preliminary analysis of the data, it was agreed that the original scope of the study could be reduced and still provide the required information.

(d) Scope of the Study

With only nine companies and a minimal expected economic impact, the scope of the study was revised to include an analysis of the industry as a whole rather than a detailed study of

Note: * Monthly Economic Letter, April 1974, FNCB industry segments. This proved to be sufficient for the development of meaningful conclusions regarding the economic impact on this industry.

METHODOLOGY OF IMPACT ASSESSMENT

The following methodology was used in assessing the economic impact of the cost of water pollution control on the ferroalloys industry:

1. The financial impact on the industry as a whole was measured in terms of the effect on the industry's average profit before taxes as a percent of sales and the effect on average profit before taxes as a percent of total assets.

2. The same analyses were performed on groups of companies with various levels of usage of wet air pollution control equipment.

3. The impact on prices of ferroalloys was determined based on the projected maintenance of the industry's historical average level of profitability before taxes. This was done for three measures of profitability:

   (a) Maintenance of the same dollar value of profits before taxes.

   (b) Maintenance of the same profit level before taxes measured in terms of "profit as a percent of sales."

   (c) Maintenance of the same profit level before taxes measured in terms of "profit as a percent of total assets."

4. The impact on production curtailment, plant closing, etc. was based on:

(a) Judgmental assessment of the expected financial impact.

(b) Interviews with industry sources.

SEGMENTATION

Segments of the industry were analyzed in considerable detail in Sections III and IV of the report. The only segmentation which resulted in a significantly different economic impact was by the type of system used to control air pollution, since there are two primary sources of water pollutants:

1. Process water used in wet-type air pollution control equipment.

2. Furnace cooling water (all plants).

Since dry air pollution control systems use no water, the only source of water pollution for plants using such a system is the cooling water.

It was found:

1. That 32% of the industry capacity is controlled by wet-type air pollution control systems.

2. That 38% of the industry is controlled by dry-type air pollution control systems.

3. That 30% of the industry capacity currently has no air pollution control system, but will probably install dry systems.

The impact due to water pollution abatement costs on those plants which utilize wet-type air pollution control systems will be much greater than the impact on plants which do not.

COST OF WATER POLLUTION CONTROL

The cost data were supplied by Datagraphics, Inc. Costs regarding investment requirements were developed on a "per megawatt of capacity" basis. Ownership and operating costs were based on "per megawatt-day" of operation.

The cost data for 1977, 1983, and new source requirements are summarized in Table 3 and were the basis for the economic impact analysis.

Table 3

Cost of Wastewater Treatment Ferroalloys Industry

Type of Furnace and Air Pollution Control System	1977 Standards (1)		1983 Standards (2)		New Source	
	Investment (per Mw)	Ownership and Operating Cost (per Mw-Day)	Investment (per Mw)	Ownership and Operating Cost (per Mw-Day)	Investment (per Mw)	Ownership and Operating Cost (per Mw-Day)
Open Furnace - Wet A/P System	$18,409	$21.01	$29,507	$37.62	- (3)	- (3)
Closed Furnace - Wet A/P System	23,488	27.11	35,747	45.11	$35,747	$45.11
Open or Closed Furnace - Dry A/P System	1,266	0.40	8,444	12.29	8,444	12.29

Notes:
(1) Best available technology (BAT).
(2) Best practicable technology (BPT).
(3) An open furnace with a wet air system would not be considered for new sources.

Source: Datagraphics, Inc.

Table 3

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Source: Datagraphics, Inc.

FINANCIAL PROFILE

Financial data on individual plants and/or ferroalloys operations of large companies were not available. However, the limited published data provide an estimated financial profile of this industry. The following table is based on current estimated sales and "typical" profitability.

Table 4

Estimated Pro Forma Industry Profitability

Sales (000)	$425,000
Profits before Taxes (000)	38,760(1)
Total Assets (000)	404,000(2)
Profits as a Percent of:	
Sales	9.12%
Total Assets	9.59%

Notes: (1) Profits are based on the reported industry average as stated by the Ferroalloys Association. The 1972 profits were not used as it was obviously a nontypical year. The 1967-1971 average profit after taxes was 4.56%. This is approximately 9.12% before taxes.

(2) The ratio of total assets to sales was estimated to be the same for the industry as for the combined data of three companies whose financial statements are published.

Sources: Field interviews, published data, and A. T. Kearney, Inc. estimates.

With an estimated before-tax profit on sales of 9.12%, the ferroalloys industry is slightly better than the return for all manufacturing firms in general.

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With an estimated before-tax profit on sales of 9.12%, the ferroalloys industry is slightly better than the return for all manufacturing firms in general.

IMPACT ANALYSIS

It was found that 14 of the 22 plants, representing over 70% of the industry's capacity, already have in operation the equipment necessary to meet 1977 standards and will require only a small investment to meet the 1983 standards. These 14 plants are distributed among eight firms. All plants operated by five of these eight firms account for 10 of the 14 plants which are able to meet 1977 standards. It has been assumed, based on interviews with industry manufacturers, that all uncontrolled plants will install dry air pollution control systems. Therefore, the standards will impose additional costs on the industry for only about 30% of its total capacity.

(a) 1977 Standards (Best Available Technology) (BAT)

The eight plants requiring additional water pollution abatement equipment are distributed among four firms and range in total furnace capacity from approximately 20 to more than 120 megawatts. The majority of these eight plants are owned by the industry sales leaders. The investment costs for the industry required to meet the 1977 standards are $9.5 million. When divided among the eight plants requiring some additional facilities, this is an average of $1.2 million per plant. The annual operating cost increase is expected to amount to $4.0 million, or an average of $500,000 for each of the eight plants. It is projected that prices will be increased between 1.0% and 1.3%. This will maintain the industry current return on total assets.

(b) 1983 Standards (Best Practicable Technology) (BPT)

The industry is projected to require an additional investment of $6.2 million in order to meet the proposed 1983 standards. The additional annual costs (versus current costs) of operation are estimated to be approximately $8 million, or between 1.9% and 2% of total industry sales.

Because of the free, competitive nature of the domestic ferroalloys market and to the extent that U.S. firms remain competitive with imports, these costs will be passed on in the form of price increases. If the industry increases prices to a level which will maintain the present estimated average return on total assets, the price increase would amount to between 2.2% and 2.4%.

This increase would have virtually no secondary effect on prices of goods such as steel. The steel industry would require a price increase of less than 0.03% in order to totally pass on the added cost of ferroalloys and maintain the existing profit level in the industry.

(c) Plant Closings

Based on the data analyzed and interviews with ferroalloy manufacturers, it is believed that the proposed water pollution control standards will have no significant effect on production levels or plant closings. Thus, there will be little effect on industry employment and no impact on local communities due to plant closings.

(d) New Source Standards

While new source standard costs are the same as those for the 1983 standards, it is difficult to evaluate the impact these standards will impose on this industry. Some of the reasons for this are:

1. Industry furnace capacity has not grown in recent years. About two new furnaces have been installed each year as replacements for older furnaces. It is possible to install a new furnace without adding any major costs for water pollution control, so the effect may be zero.

2. If an existing furnace with a wet scrubber system is replaced by a new furnace with a dry baghouse system, the annual costs would be reduced by $599,000 for 50 megawatts of capacity.

3. The replacement of a dry system with a wet system would add about $599,000 in annual costs, based on the conversion of 50 megawatts of furnace capacity.

No data were available regarding furnaces which are candidates for replacement. Because of this, it was assumed that the new source standards would have very little, if any, impact on industry profitability or growth.

(e) Other Considerations

It must be remembered that this industry is under economic pressure due to several other factors:

1. Annual air pollution control costs, preliminarily, are estimated to range from two to five times more than the costs of water pollution control. The air pollution problem is of much greater concern to the industry than water pollution control.

2. Imports have increased considerably in recent years. Ferromanganese imports amounted to 26% of consumption in 1971, 36% in 1972, and 35% in 1973. Ferrochromium imports also were high, accounting for over 44% of consumption in 1972 and 32% in 1973. The result has been a severe profit squeeze for the industry since foreign-produced ferroalloys have been delivered at lower prices than domestically produced ferroalloys. This price differential was greatly reduced in 1973 and at the end of the year, in fact, reversed itself.

3. The uncertain international monetary situation affects not only the prices of ferroalloys but also the cost of raw ores, most of which are imported.

4. The cyclical nature of the steel industry in the United States greatly affects the demand for ferroalloys. Since there is little product differentiation, competition is keen during low periods of the cycle.

These considerations are expected to have a much greater economic impact on this industry than water pollution control costs.

It is felt that the industry will be affected by all of these considerations as follows:

1. Of the 22 plants covered by this study, two are converting to the production of silicon metal, a product not included in this study.

2. Two plant closings had been announced for 1973. The high level of demand for ferroalloys kept these plants operating. These two plants were sold in 1973. The new owners plan to continue operations.

3. It was anticipated that three additional plants would close because of a combination of financial problems, air pollution control costs and other factors. These plants have continued operations, but the owners are currently negotiating their sale.

In total, by 1983, it is our opinion that the producers of the 4 ferroalloys covered by this study may consist of 8 companies operating a total of 15 plants. The reduction from the present level of 22 plants is not expected to have been a result of added water pollution control costs.

LIMITS OF THE ANALYSIS

(a) Accuracy

The accuracy of this study depends upon the accuracy of:

1. Published industry data.

2. Unpublished information supplied by knowledgeable industry personnel.

3. Cost data developed separately from this analysis by Datagraphics, Inc.

4. Estimates by A. T. Kearney consultants.

The published data consisted of industry shipments and limited financial data. While conflicts were present in various shipment data sources, these data were judged to be reasonably accurate for a study of this nature.

The information supplied by industry manufacturers was assumed to be accurate, and the cost data provided by Datagraphics, Inc. were used as supplied.

Estimates by A. T. Kearney of individual plant shipments and sales by company have an accuracy of ±20%. However, the total industry data and grouped plant or company data have an estimated accuracy of ±10%.

(b) Critical Assumptions

The assumptions which directly affect the findings and conclusions of this study are listed below.

1. It was assumed that the industry's average profitability as a percent of sales would continue to be equal to the average for the 1967-1971 period.

The assumption was based on the fact that the devalued U.S. dollar has narrowed the price gap between imported and U.S.-produced ferroalloys in 1973.

If imports can sustain lower price levels than domestically produced ferroalloys, the impact of water pollution control costs and air pollution control costs will be greater.

2. A second assumption bearing upon the impact of water pollution control costs on this industry is the continued trend to dry air pollution control systems.

Industry sources concur with this trend to dry systems, but pending air pollution control restrictions may have an effect on whether wet or dry systems are used.

If the one-third of the industry operating with no air pollution control devices adds wet air pollution control systems, the additional investment required to conform to 1983 standards would be over $9 million.

(c) Impact on Individual Companies

Obviously the economic impact on individual companies or plants will not be equal. With only nine industry manufacturers, however, it is impossible to discuss these cases without disclosing information which was obtained under promise of confidentiality.

Even a general discussion of these companies would reveal the identities to knowledgeable industry personnel. Therefore, no discussion which contained data gathered from confidential sources and could identify individual firms was presented in this report.

I - INTRODUCTION

STATEMENT OF THE PROBLEM

The 1972 amendments to the Federal Water Pollution Control Act have required the Environmental Protection Agency to establish effluent limitations for most major industries which are sources of water pollution. Studies are now under way to establish these limitations in some 28 industries. These effluent limitations will apply to existing and new plants, and at legislated dates, progressively more restrictive limitations will be imposed. Specifically, by July, 1977, effluent requirements will be in effect that require application of the best practical control technology currently available. By July, 1983, a more restrictive set of limitations will be exacted that require the application of the best available technology economically achievable; by 1985, if possible, techniques and systems that enable the industries to effect a zero level of discharge will come into effect.

The tremendous effort which has been expended by the EPA and its predecessor agencies in the technical development of the nature of the pollution problem and its solutions has resulted in a multiplicity of programs which have begun to bring the pollution problem under control. The establishment of timetables has put time parameters on these control efforts, requiring the expenditure of vast sums of money by all types and levels of industry to meet these deadlines by installation of pollution controls.

NATURE OF THE PROBLEM

In recent years a recognition of the potential economic problems facing industry in meeting the control requirements has resulted in study programs in which the economic impact of the costs of pollution control on American industry and on the economy in general has been analyzed. These culminated in the Economic Impact Studies sponsored by the Council for Environmental Quality and the EPA in 1971 and 1972, in which 11 industries were studied.

The EPA is now increasing the number of industries which are being studied and expanding the scope of previous studies by authorizing the current series of Economic Impact Studies which are specifically aimed at analyzing the economic impact of the costs of water pollution abatement requirements under the Federal Water Pollution Control Amendments of 1972.

SCOPE OF WORK

The industry which is covered by this study is the ferroalloys industry, generally defined by SIC 3313. This code includes electrometallurgical production of all grades of ferroalloys. However, the scope of this study has been limited by the Statement of Work to ferrochromium, ferromanganese, ferrosilicon, and silicomanganese produced by submerged-arc furnace processes.

METHOD OF APPROACH

This study was conducted in three phases. Phase I developed a physical and financial profile of this industry. Phase II analyzed the economic impact of water pollution control costs on the industry, and Phase III was the preparation of the final report.

The method used in conducting this study is discussed in the following paragraphs.

(a) Phase I

1. Collected and reviewed all published data and information which could be found in trade journals, government sources and A. T. Kearney files.

2. Reviewed the data and information being prepared for the joint EPA/Ferroalloys Association study of air pollution in the ferroalloys industry.

3. Met with the following in order to gather any additional information:

   (a) National Industrial Pollution Control Council, U.S. Department of Commerce

   (b) Bureau of Competitive Assessment and Business Policy, U.S. Department of Commerce

   (c) Ferroalloys Association

   (d) Datagraphics, Inc.

   (e) Environmental Protection Agency

4. Met with the Contracting Officer to redefine the scope of the study.

5. Conducted telephone interviews with each of the nine manufacturers to obtain additional necessary information.

6. Analyzed all of the data collected. A list of reference sources used in this study is given in Exhibit I-1*. In addition, Exhibit I-2 summarizes all ferroalloys producers, including companies and plants which were not in the scope of the study.

7. Prepared a draft report covering the findings of Phase I.

8. Reviewed Phase I findings and conclusions with the EPA. The results reported in Phase I indicated that the economic impact of water pollution control costs would be minimal for this industry. It was therefore decided by A. T. Kearney and the EPA that a general analysis of the industry, rather than a detailed analysis of industry segments, would be sufficient to provide the assessment of the impact on the ferroalloys industry.

(b) Phase II

1. Analyzed the data developed by Datagraphics, Inc. with respect to the projected costs of water pollution control.

2. Revised some of the data collected in Phase I due to the availability of additional information.

3. Analyzed all data collected and developed conclusions based on this analysis.

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* All exhibits are located at the end of the section in which they are discussed.

4. Prepared a draft report covering the findings and conclusions of Phase II.

(c) Phase III

The draft reports covering the results of Phase I and Phase II were combined into a single report, finalized and submitted to the EPA.

EXHIBIT I-1
Page 1 of 2

ENVIRONMENTAL PROTECTION AGENCY

LIST OF REFERENCE SOURCES

SECONDARY SOURCES

Annual financial reports of all ferroalloys manufacturers

Annual Statistical Reports, American Iron and Steel Institute

Annual Survey of Manufactures - 1971, U.S. Department of Commerce

Blast Furnace and Steel Plant

Census of Manufactures - 1972, U.S. Department of Commerce

Development Document for Effluent Limitations Guidelines and Standards of Performance - Ferroalloys Industry, Datagraphics, Inc.

Dun & Bradstreet reports

EPA/Ferroalloys Association - Joint Industry Air Pollution Control Study - Draft

Iron and Steel Engineer

Journal of Metals

Metal Statistics 1972, American Metal Market

Minerals Yearbook - 1972, Bureau of Mines, U.S. Department of the Interior

Moody's Industrial Manual

Statement for Relief from Excessive Import - 1973, The Ferroalloys Association

33 Magazine

PERSONAL INTERVIEWS

(a) Manufacturers

Airco, Inc., Airco Alloys Div.
Niagara Falls, New York

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Chromium Mining & Smelting Company, Ltd.
Montreal, Quebec, Canada

Foote Mineral Company
Exton, Pennsylvania

Interlake, Inc., Globe Metallurgical Div.
Cleveland, Ohio

IU International Corp., Tennessee Alloys Div.
Memphis, Tennessee

Mead Corporation, Woodward Div.
Woodward, Alabama

Ohio Ferroalloys Corp.
Canton, Ohio

Sandgate Corp., Tenn-Tex Alloy Div.
Houston, Texas

Union Carbide Corp., Ferroalloys Div.
Niagara Falls, New York

(b) Other

J. E. Allen & Associates, Inc.
Chicago, Illinois

Bureau of Competitive Assessment and Business
  Policy, U.S. Department of Commerce
Washington, D.C.

Bureau of Mines, U.S. Department of the Interior
Washington, D. C.

Datagraphics, Inc.
Pittsburgh, Pennsylvania

Environmental Protection Agency, Effluent
  Guidelines Division
Washington, D. C.

The Ferroalloys Association
Washington, D. C.

National Industrial Pollution Control Council,
  U.S. Department of Commerce
Washington, D. C.

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Page 2 of 2

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U.S. Department of Commerce
Washington, D. C.

ENVIRONMENTAL PROTECTION AGENCY

EXHIBIT I-2

PRODUCERS OF ALL TYPES OF FERROALLOYS IN THE UNITED STATES BY PRODUCT AND MANUFACTURING PROCESS

Company	Plant	Plants Included in Study	Products/Manufacturing Process(1)														
			FeMn	SiMn	FeSi	FeCr	Spln.	FeP	FeMo	FeNi	FeTi	FeW	FeV	FeB	FeCb	Silvery Iron	Other
Agrico Chemical Company	Pierce, Fla.							E									
Airco, Inc.	Calvert City, Ky.	X	E		E	E											
	Charleston, S.C.	X				E											
	Mobile, Ala.	X	E	E													
	Niagara Falls, N.Y.	X			E	E											
Bethlehem Steel Corporation	Johnstown, Pa.		B														
Chromium Mining & Smelting Corp.	Woodstock, Tenn.	X				E											
Climax Molybdenum Company	Langecloth, Pa.								A								
Diamond Shamrock Corporation	Kingwood, W. Va.		C														
FMC Corporation	Pocatello, Ida.							E									
Foote Mineral Company(2)	Graham, W. Va.	X			E												
	Keokuk, Ia.															E	
	Steubenville, Ohio	X				E											
	Wanatchee, Wash.	X			E												
Hanna Furnace Corporation	Buffalo, N.Y.															B	
Hanna Nickel Smelting Company	Riddle, Ore.									E							
Hooker Chemical Corporation	Columbia, Tenn.							E									
Interlake, Inc.	Beverly, Ohio	X		E	E	E											
	Selma, Ala.	X			E												
Kawecki Chemical Company	Easton, Pa.														A		A
Mobil Chemical Company	Nichols, Fla.							E									
Molybdenum Corp. of America	Washington, Pa.								A			E		E	E		
Monsanto Chemical Company	Columbia, Tenn.							E									
	Soda Springs, Ida.							E									
NL Industries, Inc.	Niagara Falls, N.Y.										E						E
New Jersey Zinc Company	Palmerton, Pa.						E										
Ohio Ferro-Alloys Corporation(3)	Brilliant, Ohio	X			E												
	Philo, Ohio	X	E	E	E												
	Powhatan Point, Ohio																E
Reading Alloys	Robesonia, Pa.												A		A		
Shield Alloy Corporation	Newfield, N.J.										A		A	A	A		A
Stauffer Chemical Company	Mt. Pleasant, Tenn.							E									
	Silver Bow, Montana							E									
Tennessee Alloy, Subs. of I.U. International Corporation	Bridgeport, Ala.	X			E												
	Kimball, Tenn.	X		E													
Tenn-Tex Alloys, Subs. of Sandgate Corporation	Houston, Texas	X	E	E													
Tennessee Valley Authority	Muscle Shoals, Ala.							E									
Union Carbide Corporation(2)	Alloy, W. Va.	X	E	E	E	E											
	Ashtabula, Ohio	X			E												
	Marietta, Ohio	X	E	E	E	E											
	Niagara Falls, N.Y.(4)																
	Portland, Oregon	X		E	E												
	Sheffield, Ala.	X			E												
United States Steel Corporation	Clairton, Pa.		B														
	McKeesport, Pa.		B														
Woodward Co., Subs. of Mead Corp.	Woodward, Ala.	X			E												
	Rockwood, Tenn.	X	E	E													

Notes: (1) Abbreviations: A, aluminothermic process; B, blast furnace; C, electrolytic process; E, electric furnace.
(2) Also produces FeB, FeCb, FeTi, FeV and other ferroalloys in some, or all, of the company's plants.
(3) Also produces FeB and some other alloys in some, or all, of the company's plants.
(4) Types of products manufactured are unknown.

Sources: 1971 Minerals Yearbook and field interviews.

II - GENERAL INDUSTRY DESCRIPTION

This section provides some general insight into the operations of the ferroalloys industry. Included is a brief description of:

- Use of ferroalloys
- Description of the manufacturing process
- Sources of water pollutants
- Ferroalloy shipments
- Forecasted growth.

USE OF FERROALLOYS

More than 50 different alloys and metals, in hundreds of various compositions and sizes, are produced by the ferroalloys industry for use in the manufacture of steel, iron and nonferrous metals. The term ferroalloy is defined as a crude alloy of iron with some other metal, used for deoxidizing molten steel and for making alloy steels. In practice, however, the term is used loosely to include alloys or compounds containing little or no iron, and even relatively pure metals, employed to introduce additive or alloying elements in the production of steel. "Addition agent" is perhaps a more correct terminology.

The demand for ferroalloys is governed to a large extent by the requirements of the iron and steel industry. Ferroalloys are used to produce steels of greater strength and corrosion resistance. Basic to both higher strength and greater corrosion resistance in steel is the deliberate adjustment of the iron and carbon content of the steel and the addition of other metals. These other metals are added in the form of the ferroalloys. Although there are approximately 20 different types of ferroalloys produced by several processes, this study was limited to the submerged-arc furnace production of the four most important ferroalloys: ferromanganese, ferrosilicon, ferrochromium, and silicomanganese.

Manganese, which is used in the production of nearly every grade of steel, generally is supplied in the form of ferromanganese or silicomanganese. The function of manganese in steel is threefold:

1. It acts as a deoxidizer and cleanser of the molten steel.
2. It combines with sulfur, thereby greatly improving the hot-working properties of the steel.
3. It acts as an alloying element to improve the strength, toughness, and response to heat treatment of various structural and engineering steels.

Ferrosilicon is used in the steel, foundry and nonferrous metal industries. Various grades of ferrosilicon are used by the steel and foundry industries as deoxidizers and alloying elements. Silicon metal is used in the aluminum industry as an alloying agent and in the chemical industry for producing silicones. Silicon is used in manufacturing steel sheets for electrical apparatus such as transformers, motors, generators, and electromagnets. The silicon content in the steel is important because it decreases the electrical energy loss from magnetization.

Ferrochromium is one of the important ferroalloys in modern iron and steel metallurgy. The well-known "stainless" and "heat-resistant" steels resist corrosion and oxidation at high temperatures because substantial percentages of chromium are present. Improved mechanical properties and increased susceptibility to heat treatment are imparted to engineering steels by adding 1.0% to 3.5% chromium.

DESCRIPTION OF THE MANUFACTURING PROCESS

Ferroalloys are produced in several ways. These include electric furnace submerged-arc smelting, alumino/silico thermic process, vacuum furnaces, and the electrolytic production of some relatively pure metals. Certain grades are also produced in the blast furnace.

Listed on the following page are the processes and the product groups manufactured by each process.

Process	Product Group
Submerged-arc furnace	Silvery iron 50% Ferrosilicon 65%-75% Ferrosilicon Silicon metal Silicon-manganese-zirconium (SiMnZr) High-carbon (HC) ferromanganese Silicomanganese Ferromanganese silicon Ferrochrome HC ferrochrome Ferrochrome-silicon Calcium carbide
Exothermic	Low-carbon (LC) ferrochrome LC ferromanganese Medium-carbon (MC) ferromanganese
Electrolytic	Chromium metal Manganese metal
Vacuum furnace	LC ferrochrome
Induction furnace	Magnesium ferrosilicon Ferrotitanium
Blast furnace	Ferromanganese Ferrosilicon

As is seen from this list, the submerged-arc electric furnace is the most versatile. This process is the most commonly used method in this industry, accounting for more than 75% of the total output. The scope of this study was limited to products manufactured by this process.

(a) Furnace Description

The general design of submerged-arc furnaces is basically the same throughout the industry. A schematic diagram is shown in Exhibit II-1. The steel furnace shell is normally cylindrical with a flat bottom and is supported on an open foundation that permits air-cooling and heat dissipation. The bottom interior of the steel shell is lined with two or more layers of carbon blocks sealed with mortar. The furnace shell's interior walls are lined with refractory or carbon brick. One or more tapholes for removing slag and metal are provided through the furnace shell at the hearth level. In some cases, the furnace is designed to rotate.

The furnace process is either batch or semi-continuous depending upon the method of charging raw materials. Power is continuously applied to the electrodes. Feed materials that consist mostly of reducing material (coal or coke), iron and steel borings and turnings, and ores may be charged to the furnace on either a continuous or an intermittent basis. Normally three electrodes are used and are suspended over the furnace hearth in a delta formation. They protrude into the furnace charge to a depth of three to five feet. This electrode depth is continually varied by mechanical or hydraulic means to maintain a constant electrical load. The trend is to the use of self-baking Soderberg electrodes. The major smelting reactions occur at "reaction zones" near the electrode tips. This smelting generates hot reaction gases (mostly carbon monoxide) and fumes of superheated metal that pass upward through the furnace charge and entrain particulate matter. Some heat from the hot gases is transferred to the charge and partially reduces the charge ore.

Originally, submerged-arc furnaces in the United States were open-top furnaces that were sometimes equipped with canopy hoods. In this configuration, gases from the furnace "reaction zone" rise through the charge, are diluted and burned with inrushing air at the charge surface, and are then discharged through stacks to the atmosphere. Because the furnace has an open top, furnace equipment such as electrode holders, electrode hangers, current conductors, and charging equipment is exposed to the radiant heat and hot furnace gases. These components must be cooled by water that is circulated through interior passages in the metal parts. Exhibit II-2 shows a cross-section of a typical open furnace and some accessory equipment.

In sealed or covered furnaces, water-cooled covers collect the uncombusted CO and other emissions. This greatly reduced the volume of emission gases which must be treated since no air is added at the surface. The concentration of pollutants in gases from these furnaces is much greater than for open furnaces.

Submerged-arc furnaces generally operate continuously except for periods of power interruption or mechanical breakdown of components. Operating time averages 90%-98%. Currently, the industry is operating at capacity.

(b) Raw Materials

Most ores come to the market in the dressed state and are sold based on their content of the desired metal oxide, i.e., manganese oxide, chromium oxide, etc. In general, ores containing high percentages of metal oxides are easier to process and result in lower production costs than ores with lower percentages of metal oxides.

The United States depends almost entirely upon foreign sources of manganese and chromium ores. Ferroalloy plants maintain substantial stocks of manganese and chromium ores. Silicon, however, is in plentiful supply within the United States as it is throughout the world. Data concerning the imports of manganese and chromite ores are shown in Exhibits II-3 and II-4 respectively. Producers of ferroalloys for export to the United States is discussed in a later section.

Shipments of ore, plus the required quartzes or quartzites, lime, scrap iron and steel turnings and borings, and reducing agents, are generally transported to plants by rail or river barge. Ores are unloaded by traveling cranes or railroad-car dumpers and moved with belt conveyors to storage areas. The quantities stored depend on the furnace capacity, marketing situation and storage capacity of the plant.

The furnace charge must be carefully prepared to manufacture a specific ferroalloy. Free moisture in the raw materials ranges from 10% to 20%. In some plants, raw materials are dried before they are fed to the furnaces.

Size of the ore is important; it should be neither too large nor too small. Oversize ores and steel turnings must be crushed to a suitable size. Fine ores, such as flotation concentrates, cannot be charged directly into a submerged-arc furnace because they lack porosity and do not allow the release of reaction gases. Dust losses when charging fine ores into a submerged-arc furnace may be as high as 15% of the ore charged.

After preparation, the raw materials are conveyed to a mix house where they are weighed and blended. The weighed mix is then moved by conveyors, buckets, skip hoists, or cars to the hoppers above the furnaces, where it may flow by gravity through chutes to the furnaces.

(c) Finished Goods

Ferroalloy products are marketed in a broad range of sizes depending on final usage, from pieces weighing 75 pounds to granules of 100 mesh or finer. Ferroalloys are intermediate products, and are usually melted and blended with molten metal. For this reason, the ferroalloy product size is important.

Molten ferroalloys from the submerged-arc furnaces are generally tapped into refractory-lined ladles or into molds or chills for cooling. The chills are low, flat, iron or steel pans that allow heat to radiate rapidly from the molten metal. After the ferroalloy has cooled to a workable temperature, it is cleaned of adhering slag and sized to market specifications.

Sizing consists of breaking the large chills by drop weights or hammers, followed by crushing (with large jaw crushers, roll mills, or grinders) and screening. Conveyors and elevators move the product between the crushing and screening operations. Storage bins hold the finished or intermediate products.

SOURCES OF WATER POLLUTANTS

Large quantities of water are used in the cooling of ferroalloy furnaces and also in wet-type air pollution control devices (scrubbers and electrostatic precipitators).

Furnace cooling requires by far the largest portion of the water used in ferroalloy manufacturing processes. From 700 to 2,500 gallons per minute may be needed to cool the furnace and certain components of the electrical conductors. Additional water is, of course, required for wet-type air pollution control devices, and approximately one-third of the furnaces in the ferroalloy industry use such devices. The remaining two-thirds either use air pollution control devices which do not require the use of water or currently have none at all.

Water quantity needed for furnace cooling ranges from 3,000 to 10,000 gallons per megawatt-hour. For scrubbers, usage ranges from 500 to 3,500 gallons per megawatt-hour. Since each ferroalloy plant may differ in its water needs, typical water requirements are difficult to establish. Water use may range from 0.5 million gallons per day for a small plant to 100 million gallons per day for a large plant.

Treatment facilities for the scrubber water differ, depending on the product being made and the type of scrubber system used. Water pollutants from a ferroalloy plant include suspended insoluble metal compounds, soluble metal compounds, cyanides, acid or basic effluents, tars, and thermal pollution. Chemical and physical treatment of the waste streams are usually sufficient; biological treatment methods are not normally considered necessary.

Scrubber water is always clarified to remove the dust scrubbed from the ferroalloy furnace fumes. The scrubber water also dissolves contaminants in the vapor phase, including cyanide and carbon monoxide.

Cyanides are found in the water from scrubber systems serving closed and covered furnaces and are extremely toxic, especially at low pH.

Exhibit II-5 shows a flow diagram of a typical wastewater treatment facility. Because cyanide is not always present in the effluent, the cyanide removal part of this system is shown by broken lines.

In summary, it can be seen that there are two sources of water pollution with which this study is concerned:

1. Water used for furnace cooling purposes in all furnaces.
2. Water used in connection with air pollution control devices in approximately one-third of the furnaces.

The current version of the effluent limitations however, has deleted consideration of noncontact furnace cooling water. The analysis of economic impact considers the total costs associated with both sources of water pollution and indicates the percentages of those costs attributable to noncontact cooling water.

FERROALLOYS SHIPMENTS

Data reflecting the position of the ferroalloys industry are available in many forms. The most meaningful data seem to be those developed by the Ferroalloys Association based on information supplied by its members and on data collected by the Bureau of Mines. These data are discussed in the following paragraphs.

(a) U.S. Manganese Ferroalloys Consumption

Manganese ferroalloys represent the largest ferroalloy group in terms of tonnage. This includes silicomanganese and ferromanganese. Consumption of these alloys is shown in Exhibit II-6. This exhibit shows that consumption of ferromanganese and silicomanganese totaled an estimated 825,400 short tons in 1972 and increased to 966,500 short tons in 1973. Consumption in 1972 increased 4.6% over that in 1971. The 1973 consumption increased 17.1% over that of the previous year and was 2.5% greater than the previous peak of 942,400 tons occuring in 1969.

The consumption of all manganese ferroalloys in the United States follows domestic iron and steel production. The consumption pattern of ferromanganese, which is used in virtually all grades of steel, follows the pattern of total steel production, as shown in Exhibit II-7. The Iron and Steel Industry accounts for more than 90% of the domestic ferromanganese consumption.

(b) U.S. Ferrosilicon Alloy Consumption

Consumption of the various grades of ferrosilicon is also shown in Exhibit II-6. This group of ferroalloys has shown the greatest increase in consumption, 63.4%, from 1967 to 1973. This is an average compounded growth rate of better than 8.5% per year.

The 1973 consumption of ferrosilicon exceeded 350,000 short tons of contained silicon. This is about 545,000 tons of gross weight alloy. The 50% FeSi alloy is the largest segment of this group accounting for 62.8% of the total ferrosilicon consumption based on contained silicon.

(c) U.S. Ferrochromium Alloys Consumption

The growth in ferrochromium alloy consumption is closely related to the production of stainless steel. This is shown in Exhibit II-7.

Exhibit II-6 shows that 270,000 short tons of contained chromium were consumed in 1973. This is a 33.3% increase over 1972.

(d) Imports/Exports of Ferroalloys

As in the case with steel, the ferroalloys industry is a world market with conditions in one country affecting those in others. Since the United States depends upon imports of the ores required to produce ferromanganese and ferrochromium, it is not suprising that foreign sources have turned to producing these ferroalloys themselves for export to the United States. Import data for the years 1970, 1971 and 1972 for ferromanganese and ferrochromium are shown in Exhibitis II-8 and II-9 respectively.

These exhibits show, based on contained element, more than a 20% increase in imported tons of ferromanganese between 1970 and 1972. Over the same period, the total tons of imported ferrochromium increased 240%. These increases explain to a large extent the decreases in imported manganese and chromite ores, (See Exhibits II-3 and II-4).

The emerging and developing nations rich in these ores find it more profitable to export finished products than to ship raw materials. Decreased transportation costs per ton of contained element, lower cost labor, and in some countries inexpensive electric power, induce nations to produce and export ferroalloys.

The following table displays percentage increases in imported tons of contained element between 1971 and 1972 for selected countries.

Percentage Increases: Imported Tons of Contained Element (1971 to 1972)

Country	FeMn	FeCr
Brazil	*	199.3%
Rhodesia	**	***
Republic of South Africa	70.1%	151.5%
Turkey	--	527.1%

Notes: * 4,592 tons in 1972, none in 1971.
** 1,210 tons in 1972, none in 1971.
*** 10,656 tons in 1972, none in 1971.

Source: Exhibits II-8 and II-9

It is expected that foreign capacities to produce ferroalloys will increase. In 1973 Brazil increased its ferrochromium capacity by 33,000 tons, most of which is for export. The largest expansions are occuring in the Republic of South Africa where by 1974 production capacity increases are expected to reach 325,000 tons. Better than 90% of these increases are planned for export.

As can be seen in Exhibit II-10, exports of U.S. ferroalloys are small and have little effect on the world market. However, U.S. imports of ferroalloys have a significant impact on the domestic industry and its markets as shown in Exhibit II-11. The following should be noted from this exhibit:

1. Imports in 1973 increased substantially from 1971, both in quantity and in percent of total consumption.

2. Ferrochromium imports have shown the greatest impact, with 1971 imports accounting for 32% of consumption, 1972 imports for 44% of consumption, and 1973 imports for 37% of consumption.

3. From 1967 through 1971, ferromanganese imports, including siliconamganese, have ranged between 19% and 27% of consumption. In 1972 imports accounted for 36.4% of consumption and in 1973 34.5% of consumption.

4. Ferrosilicon imports have been relatively unimportant, accounting for less than 6.5% of consumption for the years 1967 through 1971. In 1972 imports were nearly 8% of consumption and in 1973 imports jumped to account for 17% of consumption.

It is seen from this exhibit that imported ferroalloys represent significant shares of U.S. consumption. This is due largely to the lower cost of imported products and the availability of electric power. Depending upon the alloys and the year, prices of ferroalloy imports were reported to range from 5% to 15% less than quoted U.S. prices.

The effect of ferroalloy imports on the production of U.S. manufacturers is demonstrated in Exhibit II-12. This exhibit was derived from the data in Exhibits II-6 and II-11, which were used to calculate the apparent domestically supplied ferroalloys for domestic consumption. The data in Exhibit II-12 shows for U.S. producers of ferroalloys that:

1. Since 1968 shipments of manganese alloys have been declining until 1973 when they rebounded to slightly less than 1970 level, a 20.6% increase over 1972. Noncaptive shipments experienced a similar decline and have also increased approximately 21% over the 1972 level.

2. Ferrosilicon shipments have been increasing. Shipments in 1971 were 23.3% higher than in 1967, 1972 showed a further increase of 4.2%, and 1973 increased 13.3% relative to 1972.

3. Shipments of ferrochromium alloys remained steady from 1967 to 1970 at about 150,000 to 160,000 short tons of contained chromium per year. The level in 1971 and 1972 has declined to around 113,000 to 114,000 tons. This decrease was largely due to increased imports. Shipments in 1973 exceeded 170,000 short tons of contained element.

These data combine to show that the ferroalloys industry in the United States has not been growing. The only products of those being studied which have shown an increase in shipments have been the ferrosilicons. These alloys can be supplied from domestic raw materials and electrical power represents a larger share of the cost per ton of product than the other ferroalloys.

Preliminary 1973 data indicate that, although imports had a slightly lesser effect with respect to consumption, imported tonnage experienced significant increases. Thus it seems evident that imports will continue to be a major factor in the U.S. ferroalloys market.

FORECASTED GROWTH

The growth of ferroalloys consumption will parallel the growth of the steel industry. U.S. raw steel production is projected to reach 180 million tons by 1982.* This is a projected average annual compounded growth rate of 2.5% per year.

The consumption of ferroalloys is projected to show a similar rate of growth. However, the domestic industry has shown little or no growth in recent years. It is expected that the growth of U.S. production will be less than 2.5% due to the continued impact of imported ferroalloys.

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* Economic Analysis of Proposed Effluent Guidelines, The Integrated Iron and Steel Industry.

EXHIBIT II-1

ENVIRONMENTAL PROTECTION AGENCY

SIMPLE DIAGRAM OF SUBMERGED-ARC FURNACE

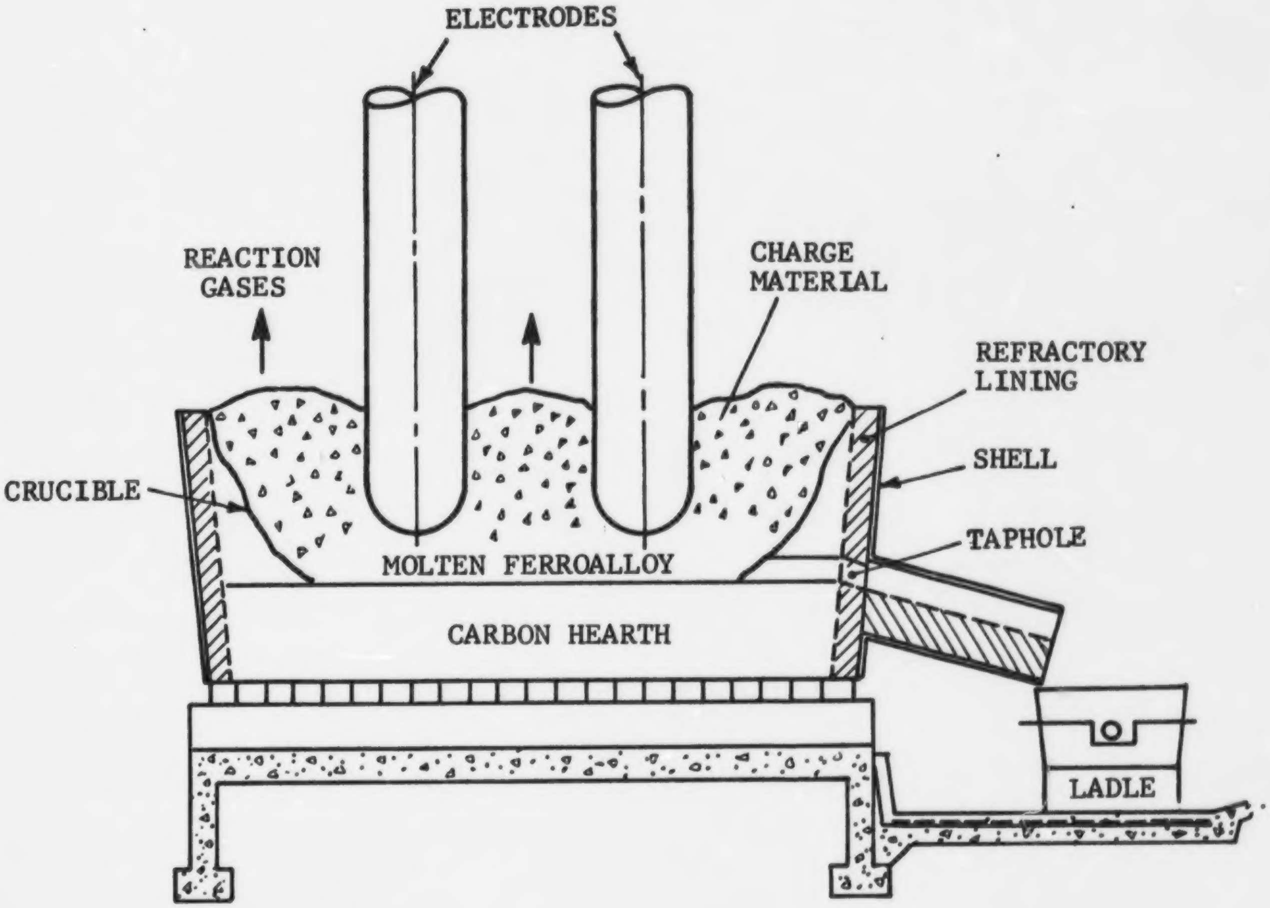
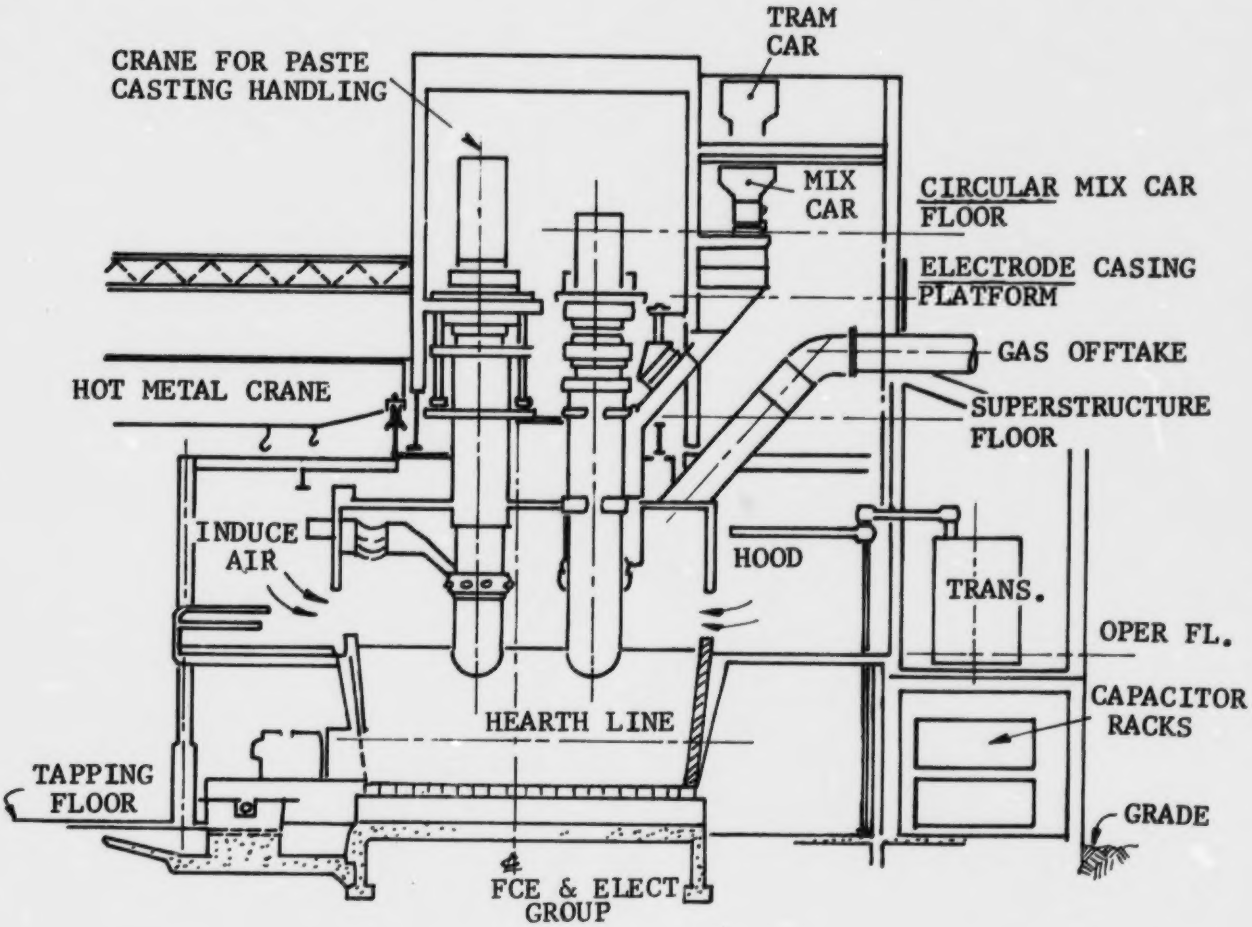

ELECTRODES
REACTION GASES
CHARGE MATERIAL
REFRACTORY LINING
SHELL
CRUCIBLE
TAPHOLE
MOLTEN FERROALLOY
CARBON HEARTH
LADLE

EXHIBIT II-2

ENVIRONMENTAL PROTECTION AGENCY

CROSS SECTION OF AN OPEN FURNACE


TRAM CAR
CRANE FOR PASTE CASTING HANDLING
MIX CAR
CIRCULAR MIX CAR FLOOR
ELECTRODE CASING PLATFORM
GAS OFFTAKE
HOT METAL CRANE
SUPERSTRUCTURE FLOOR
INDUCE AIR
HOOD
TRANS.
OPER FL.
CAPACITOR RACKS
HEARTH LINE
TAPPING FLOOR
GRADE
℄ FCE & ELECT GROUP

ENVIRONMENTAL PROTECTION AGENCY

U.S. IMPORTS(1) OF MANGANESE ORE, BY COUNTRY
(35% or More Mn)

Country	1971 Gross Weight (Short Tons)	1971 Mn Content (Short Tons)	1971 Value (Thousands)	1972 Gross Weight (Short Tons)	1972 Mn Content (Short Tons)	1972 Value (Thousands)
Angola(2)	56,721	27,603	$ 982	35,570	17,160	$ 1,244
Australia	107,593	52,630	2,629	82,587	40,261	1,575
Brazil	701,772	334,851	14,852	404,972(3)	192,827	8,217
Canada	18,495	8,547	595	11	5	(4)
Congo (Brazzaville)(5)	-	-	-	33,521	16,760	64
Gabon(6)	597,102	305,589	13,409	473,142	236,821	10,669
Ghana	78,271	37,815	2,040	46,940	22,062	1,237
India	2,900	1,283	43	25,593	12,400	620
Mexico	27,291	12,986	492	70,655	32,731	1,803
Morocco	24,460	12,730	1,205	26,309	13,936	1,277
Singapore	193	106	11	-	-	-
South Africa, Republic of	185,636	87,358	3,705	142,354	65,742	2,715
Turkey	8,064	3,790	220	-	-	-
Zaire	105,766	52,834	2,001	278,598(7)	141,990	4,894
Total	1,914,264	938,122	$42,184	1,620,252(3)	792,695	$34,315

Notes:
(1) Quantities for general imports and imports for consumption were identical.
(2) Part or all of the ore reported to have come from Angola in 1971 and 1972 is believed to have originated in Gabon
(3) It appears that up to 225,000 additional tons (gross weight) may have come from Brazil in 1972.
(4) Less than 1/2 unit.
(5) Actually from Gabon.
(6) In addition, in 1971, some imports reported as Angola may be originated in Gabon. In addition, in 1972 Gabon imports reported as Congo (Brazzaville) were approximately 35,000 tons (gross weight), Gabon imports reported as Zaire were approximately 130,000 tons (gross weight), and some or all of the imports reported as Angola probably originated in Gabon.
(7) In 1972, actual imports originating in Zaire were approximately 150,000 tons (gross weight); see footnote 6.

Source: 1972 Minerals Yearbook, preprint.

EXHIBIT II-3

EXHIBIT II-4

ENVIRONMENTAL PROTECTION AGENCY

U.S. IMPORTS FOR CONSUMPTION OF CHROMITE, BY GRADE AND COUNTRY
(Thousand Short Tons and Thousand Dollars)

Country	Not More Than 40% Cr_2O_3			More Than 40% but Less Than 46% Cr_2O_3			46% or More Cr_2O_3			Total		
	Gross Weight	Cr_2O_3 Content	Value	Gross Weight	Cr_2O_3 Content	Value	Gross Weight	Cr_2O_3 Content	Value	Gross Weight	Cr_2O_3 Content	Value
1971:												
Finland	-	-	-	(1)	(1)	$ 1	-	-	-	(1)	(1)	$ 1
Iran	-	-	-	-	-	-	12	5	$ 381	12	5	381
Pakistan	-	-	-	-	-	-	35	17	1,013	35	17	1,013
Philippines	147	48	$3,055	12	5	207	-	-	-	159	53	3,262
Rhodesia, Southern	-	-	-	-	-	-	26	12	768	26	12	768
South Africa, Republic of	11	4	134	271	120	3,177	140	65	1,961	422	189	5,272
Turkey	83	32	1,894	75	33	2,313	180	85	6,056	338	150	10,263
U.S.S.R.	33	13	812(r)	-	-	-	274	151	10,101(r)	307	164	10,913(r)
Total	274	97	$5,895(r)	358	158	$5,698	667	335	$20,280(r)	1,299	590	$31,873(r)
1972:												
Iran	-	-	-	14	6	$ 346	-	-	-	14	6	$ 346
Malagasy Republic	13	4	$ 390	-	-	-	-	-	-	13	4	390
Pakistan	-	-	-	-	-	-	27	13	909	27	13	909
Philippines	122	39	2,835	-	-	-	9	4	201	131	43	3,036
Rhodesia, Southern	-	-	-	27	12	876	65	31	1,876	92	43	2,752
South Africa, Republic of	-	-	-	141	62	1,704	108	51	1,520	249	113	3,224
Turkey	32	13	742	13	6	368	56	34	1,804	101	52	2,914
U.S.S.R.	63	24	909	-	-	-	371	202	13,147	434	226	14,056
Total	230	80	$4,876	195	86	$3,294	636	335	19,457	1,061	501	$27,627

Notes: (r) Revised.
(1) Less than 1/2 unit.

Source: 1972 Minerals Yearbook, preprint.

EXHIBIT II-5

ENVIRONMENTAL PROTECTION AGENCY

FLOW DIAGRAM OF TYPICAL WASTEWATER TREATMENT FACILITY

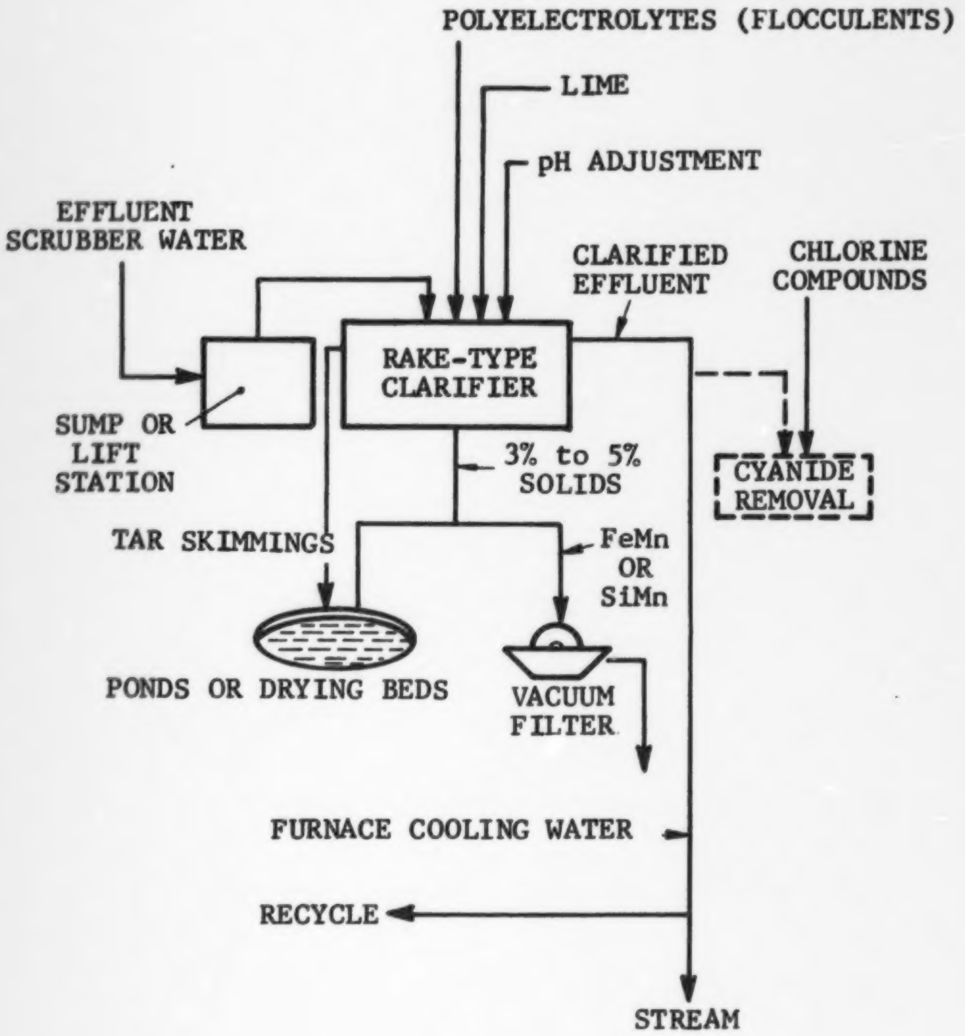

POLYELECTROLYTES (FLOCCULENTS)
LIME
pH ADJUSTMENT
EFFLUENT SCRUBBER WATER
CLARIFIED EFFLUENT
CHLORINE COMPOUNDS
RAKE-TYPE CLARIFIER
SUMP OR LIFT STATION
3% to 5% SOLIDS
CYANIDE REMOVAL
TAR SKIMMINGS
FeMn OR SiMn
PONDS OR DRYING BEDS
VACUUM FILTER
FURNACE COOLING WATER
RECYCLE
STREAM

EXHIBIT II-6

ENVIRONMENTAL PROTECTION AGENCY

U.S. CONSUMPTION OF SELECTED FERROALLOYS
1961 TO 1973

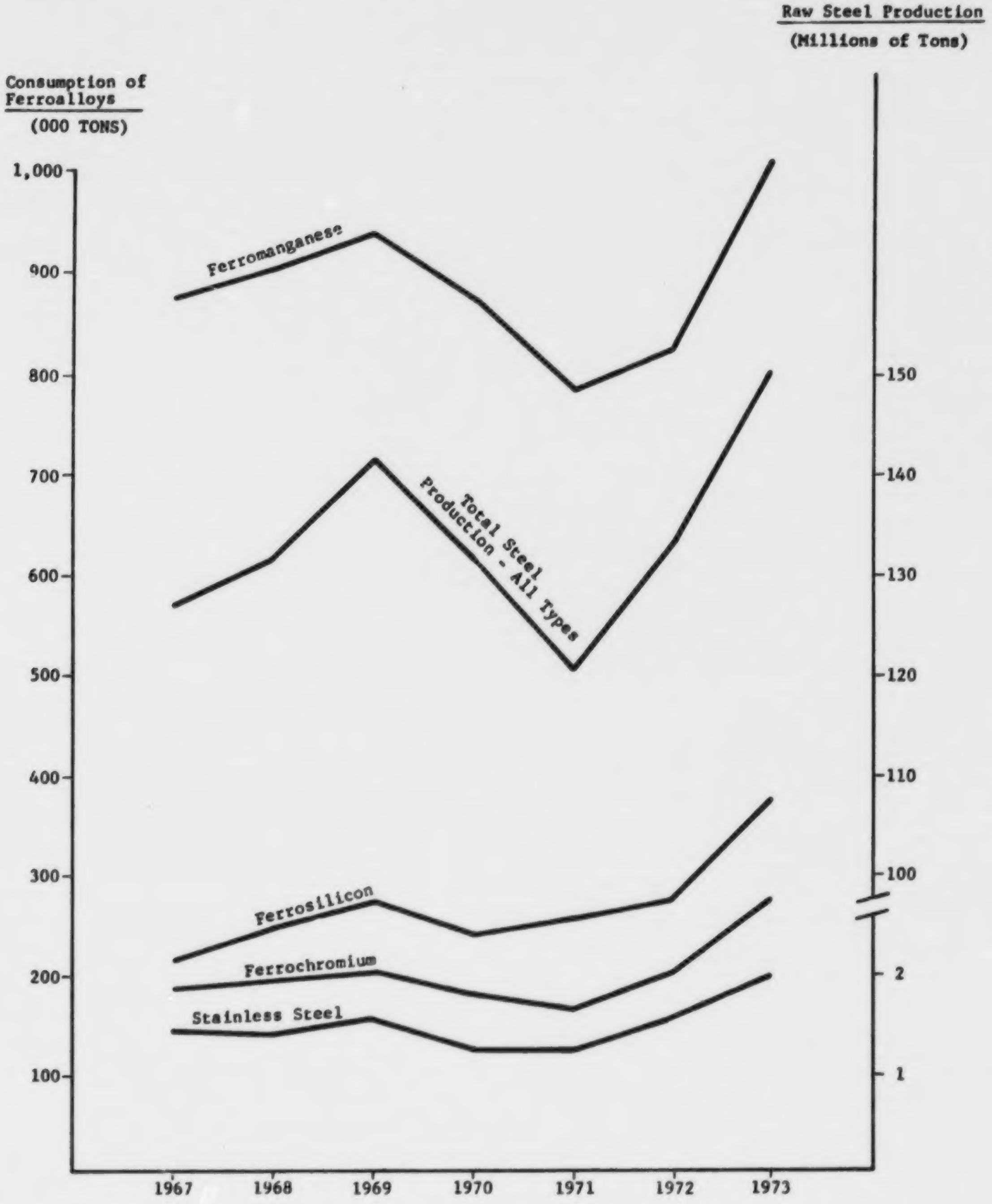
	U.S. Consumption in Thousands of Short Tons of Contained Element								Percent Change		
							Preliminary				
Type of Ferroalloy	1961-1966 Average	1967	1968	1969	1970	1971	1972	1973	1967 to 1971	1971 to 1972	1972 to 1973
Manganese Alloys											
High-Carbon Ferromanganese-Total	670.0	664.2	707.6	735.5	679.5	601.5	627.8	730.4	-9.4%	4.4%	16.3%
-Noncaptive	402.0	382.0	417.6	425.0	393.5	356.0	358.3	407.6	-6.8	0.6	13.8
Medium- and Low-Carbon Ferromanganese	66.6	108.6	90.7	106.3	107.5	106.5	117.3	132.8	-1.9	10.1	13.2
Silicomanganese	102.1	105.5	108.7	100.6	91.4	81.1	80.3	103.3	-22.5	-1.0	28.6
Subtotal-All Usage	838.7	878.3	907.0	942.4	878.4	789.1	825.4	966.5	-10.2	4.6	17.1
-Noncaptive	570.7	596.1	617.0	631.9	592.4	543.6	555.9	643.7	-8.8	2.3	15.8
Ferrosilicon Alloys											
50% FeSi	127.3	153.9	171.7	188.5	156.0	172.5	179.8	220.9	12.1	4.2	22.9
60%-80% FeSi	59.7	51.1	66.7	72.5	73.0	71.4	90.9	112.4	39.7	27.3	23.7
80%-95% FeSi	11.5	9.2	10.4	12.7	12.2	15.2	9.0	18.6	65.2	2.2	106.7
Subtotal	198.5	214.2	248.8	273.7	241.2	259.1	279.7	351.9	21.0	8.0	25.8
Ferrochromium Alloys											
High-Carbon Ferrochrome	74.1	88.9	90.0	93.5	76.7	81.7	121.1	168.5	-8.1	48.2	39.1
Low-Carbon Ferrochrome	92.4	100.0	104.9	109.7	105.1	87.2	82.2	102.4	-12.8	-5.7	24.6
Subtotal	166.5	188.9	194.9	203.2	181.8	168.9	203.3	270.9	-10.6	20.4	33.3

Source: The Ferroalloys Association and Bureau of Mines.

EXHIBIT II-7

ENVIRONMENTAL PROTECTION AGENCY

CONSUMPTION OF FERROALLOYS AND PRODUCTION OF RAW STEEL - BY YEAR 1967 - 1973



Sources: The Ferroalloys Association
Bureau of Mines
AISI

ENVIRONMENTAL PROTECTION AGENCY

U.S. IMPORTS FOR CONSUMPTION OF FERROMANGANESE, BY COUNTRY

Country	1970			1971			1972		
	Gross Weight (Short Tons)	Mn Content (Short Tons)	Value (Thousands)	Gross Weight (Short Tons)	Mn Content (Short Tons)	Value (Thousands)	Gross Weight (Short tons)	Mn Content (Short Tons)	Value (Thousands)
Belgium-Luxembourg	551	423	$ 60	1,456	1,136	$ 198	9,911	7,775	$ 1,172
Brazil	-	-	-	-	-	-	6,079	4,592	667
Canada	357	288	90	570	460	118	597	460	211
Chile	613	536	96	-	-	-	-	-	-
France	100,036	77,745	10,285	92,321	71,481	10,944	100,084	78,382	14,067
Germany, West	8,342	6,499	1,022	1,552	1,329	599	707	603	267
India	35,597	27,128	3,255	32,717	24,463	3,769	13,093	9,950	1,516
Italy	1,111	896	199	652	546	166	3,026	2,442	718
Japan	5,556	4,373	913	2,757	2,133	488	29,050	23,179	5,374
Mozambique	12,340	9,648	1,485	-	-	-	-	-	-
Netherlands	2,065	1,611	194	-	-	-	-	-	-
Norway	3,291	2,577	351	14,523	11,633	2,333	25,624	20,181	3,145
Rhodesia	-	-	-	-	-	-	1,504	1,210	171
South Africa, Republic of	119,292	93,759	13,161	90,078	70,892	12,089	152,441	120,617	20,866
Sweden	1,795	1,496	452	5,469	4,640	1,530	6,423	5,326	1,672
United Kingdom	-	-	-	-	-	-	(1)	(1)	(1)
Yugoslavia	-	-	-	683	547	158	-	-	-
Total	290,946	226,979	31,563	242,778	189,260	32,392	348,539	274,717	49,846

Note: (1) Less than 1/2 unit.

Sources: 1971 Minerals Yearbook, and 1972 preprint.

EXHIBIT II-8

EXHIBIT II-9

ENVIRONMENTAL PROTECTION AGENCY

U.S. IMPORTS FOR CONSUMPTION OF FERROCHROMIUM, BY COUNTRY

(Short Tons and Thousand Dollars)

Year and Country	Low-Carbon Ferrochromium (Less Than Three Percent Carbon) Quantity Gross Weight	Low-Carbon Ferrochromium Quantity Chromium Content	Low-Carbon Ferrochromium Value	High-Carbon Ferrochromium (Three Percent or More Carbon) Quantity Gross Weight	High-Carbon Ferrochromium Quantity Chromium Content	High-Carbon Ferrochromium Value
1970:						
Finland	-	-	-	5,919	3,347	$ 638
France	28	21	$ 9	-	-	-
Germany, West	2,579	1,910	922	4,453	3,037	902
Japan	310	210	71	347	236	73
Norway	3,387	2,362	1,081	489	352	121
South Africa, Republic of	19,735	12,158	4,517	1,120	620	140
Sweden	2,933	2,192	1,146	-	-	-
Total	28,972	18,853	$7,746	12,333	7,592	$ 1,874
1971:						
Belgium-Luxembourg	-	-	-	110	71	$ 25
Brazil	-	-	-	1,382	847	291
Canada	184	111	$ 43	515	360	159
Finland	-	-	-	10,903	5,772	1,138
France	1,086	773	425	4,255	2,927	1,125
Germany, West	5,033	3,728	2,343	6,738	4,392	1,620
India	2,260	1,623	800	-	-	-
Japan	7,390	4,882	2,943	12,992	8,363	2,924
Norway	3,458	2,409	1,460	300	211	85
South Africa, Republic of	14,633	8,661	3,459	7,174	3,871	956
Sweden	5,434	4,036	2,492	220	151	52
Turkey	1,120	750	357	-	-	-
Total	40,598	26,973	$14,322	44,589	26,965	$ 8,375
1972:						
Belgium-Luxenbourg	39	28	$ 17	1,554	1,021	$ 237
Brazil	-	-	-	4,205	2,535	651
Canada	45	30	17	-	-	-
Finland	-	-	-	6,887	3,612	681
France	465	366	177	-	-	-
Germany, West	2,949	2,163	1,211	2,316	1,519	501
Italy	-	-	-	1,653	1,075	320
Japan	14,134	9,598	5,434	3,577	2,267	736
Netherlands	-	-	-	827	556	183
Norway	6,282	4,505	2,422	3,318	2,272	766
Rhodesia, Southern	3,578	2,581	1,403	11,835	8,075	1,910
South Africa, Republic of	23,095	14,406	5,955	30,890	17,113	4,361
Sweden	9,608	7,125	3,958	1,171	796	269
Turkey	6,882	4,703	2,312	-	-	-
Yugoslavia	1,117	774	416	4,844	3,176	651
Total	68,194	46,249	$23,322	73,077	44,017	$11,266

Sources: 1971 Minerals Yearbook, and 1972 preprint.

EXHIBIT II-10

ENVIRONMENTAL PROTECTION AGENCY

U.S. EXPORTS OF FERROALLOYS

Year	Exports-Contained Element (Thousands of Tons)			Exports as a Percent of U.S. Consumption		
	FeMn	FeSi	FeCr	FeMn	FeSi	FeCr
1967	1.5	7.1	9.0	0.2%	3.3%	4.8%
1968	3.0	11.0	18.2	0.3	4.4	9.3
1969	1.4	3.9	16.5	0.1	1.4	8.1
1970	17.4	26.8	19.0	2.0	11.1	10.5
1971	3.6	15.3	6.1	0.5	5.9	3.6
1972	5.5	4.4	8.6	0.7	1.6	4.2
1973	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
1967-1972 Average				0.6%	4.6%	6.8%

Source: The Ferroalloys Association, based on gross weight plus estimated contained elements as follows:

Mn - 80%
Si - 60%
Cr - 67%

EXHIBIT II-11

ENVIRONMENTAL PROTECTION AGENCY

U.S. IMPORTS OF SELECTED FERROALLOYS 1967 TO 1973

Type of Ferroalloy	U.S. Imports in Thousands of Short Tons of Contained Element 1967	1968	1969	1970	1971	Preliminary 1972	Preliminary 1973	Imports as a Percent of Total Consumption Based on Contained Element 1967	1968	1969	1970	1971	Preliminary 1972	Preliminary 1973
Manganese Alloys														
High-Carbon FeMn	145.2	140.8	203.0	207.9	161.3	227.1	264.8	21.9%	20.0%	27.6%	30.6%	26.8%	36.2%	36.3%
Medium- and Low-Carbon FeMn	22.3	17.5	31.5	19.1	27.9	47.6	39.0	20.5	19.3	29.6	17.8	26.2	40.6	29.3
SiMn	23.4	16.9	21.3	9.6	19.6	25.9	30.1	22.2	15.5	21.2	10.5	24.1	32.3	29.1
Subtotal	190.9	175.2	255.8	236.6	208.8	300.6	333.9	21.7	19.3	27.1	26.9	26.5	36.4	34.5
Ferrosilicon Alloys														
50% FeSi	1.9	2.0	2.0	1.9	2.7	3.8	3.8	1.2	1.2	1.1	1.2	1.6	2.1	1.7
60%-80% FeSi	11.5	5.7	10.3	6.3	8.9	18.2	55.7	22.4	8.6	14.2	8.7	12.4	20.0	49.5
80%-95% FeSi	0.2	0.3	0.1	0.1	0.1	-	0.4	1.7	2.8	0.8	0.7	0.4	-	2.1
Subtotal	13.6	8.0	12.4	8.3	11.7	22.0	59.9	6.3	3.2	4.5	3.4	4.5	7.9	17.0
Ferrochromium Alloys														
High-Carbon FeCr	5.7	5.2	10.7	7.6	27.0	44.0	69.5	6.4	5.8	11.5	9.9	33.0	36.3	41.2
Low-Carbon FeCr	32.8	34.8	30.7	18.4	27.0	46.3	30.2	32.8	34.1	28.0	17.5	31.0	56.3	29.5
Subtotal	38.5	40.0	41.4	26.0	54.0	90.3	99.7	20.4	20.5	20.4	14.3	32.0	44.4	36.8

Source: The Ferroalloys Association and Bureau of Mines.

EXHIBIT II-12

ENVIRONMENTAL PROTECTION AGENCY

U.S. SHIPMENTS OF FERROALLOY FOR U.S. CONSUMPTION

Type of Ferroalloy	Shipments in Thousands of Short Tons of Contained Element							Percent Change		
						Preliminary				
	1967	1968	1969	1970	1971	1972	1973	1967 to 1971	1971 to 1972	1972 to 1973
Manganese Alloys										
High-Carbon FeMn-Captive	282.2	290.0	310.5	286.0	245.5	269.5	322.8	-13.0%	9.8%	19.8%
-Noncaptive	236.8	276.8	222.3	185.6	194.7	131.2	142.8	-17.8	-32.6	8.8
Medium- and Low-Carbon FeMn	86.3	73.2	74.8	88.4	78.6	69.7	93.8	-8.9	-11.3	34.6
SiMn	82.1	91.8	79.3	81.8	61.5	54.4	73.2	-25.1	-11.5	34.6
Subtotal-All Usage	687.4	731.8	686.9	641.8	580.3	524.8	632.6	-15.6	-9.6	20.5
-Noncaptive	405.2	441.8	376.4	355.8	334.8	255.3	309.8	-17.4	-23.7	21.3
Ferrosilicon Alloys										
50% FeSi	152.0	169.7	186.5	154.1	169.8	176.0	217.1	11.7	3.7	23.4
60%-80% FeSi	39.6	61.0	62.2	66.7	62.5	72.7	56.7	57.8	16.3	-22.0
80%-95% FeSi	9.0	10.1	12.6	12.1	15.1	9.0	18.2	67.8	-	-
Subtotal	200.6	240.8	261.3	232.9	247.4	257.7	292.0	23.3	4.2	13.3
Ferrochromium Alloys										
High-Carbon FeCr	83.2	84.8	82.8	69.1	54.7	77.1	99.0	-34.3	41.0	28.4
Low-Carbon FeCr	67.2	70.1	79.0	86.7	60.2	35.9	72.2	-10.4	-40.4	101.1
Subtotal	150.4	154.9	161.8	155.8	114.9	113.0	171.2	-23.6	-1.7	51.5

Sources: Exhibits II-6 and II-11.

III - PHYSICAL CHARACTERISTICS OF THE INDUSTRY

This section provides a profile of the physical characteristics of the firms and plants in the Ferroalloys Industry.

GENERAL BACKGROUND

Currently there are only nine companies in the industry operating 22 plants which conform to the parameters of the study's scope; i.e., which produce at least one of the four ferroalloys being studied and use the electrometallurgical process. These companies are listed in Exhibit III-1.

The companies range in annual 1972 sales from about $20 million to $3 billion and many are widely diversified. The 1972 estimated industry shipments of these four ferroalloys is $425 million. The 1973 estimate is $535 million. Based on data gathered, 8,117 employees were involved in the production of ferroalloys in 1972.

TYPES OF FIRMS

(a) Size

The companies were grouped according to corporate size in Exhibit III-2. It is seen from this exhibit that:

1. There are three firms with total 1972 sales greater than $1 billion. These companies operate nine of the 22 plants and account for about 56% of the total employees in this industry.

2. There are two companies whose total 1972 sales are between $100 million and $1 billion. These companies, collectively, operate six plants. The combined work force of 1,681 employees accounts for 20.7% of the industry's total.

3. There are four firms whose 1972 corporate sales are leass than $100 million. These companies operate seven plants with 1,899 employees.

(b) Number of Plants

Exhibit III-3 shows the breakdown of the number of plants per firm.

1. Two companies each have a single plant while four firms operate two plants. These six companies together employ nearly 30% of the industry's work force and produced about 38% of total 1972 shipments.

2. The remaining three companies operate three, four, and five plants respectively. These three companies (12 plants) employ 5,697, which is 70.2% of the industry, and account for 1972 shipments of $265 million, or 62.5% of the total.

These data have been grouped to preserve the confidentiality of the data collected in this study. However, it is clear that three multi-plant companies account for about two-thirds of the industry's output and work force although none of these three firms derived more than 40% of its total 1972 sales from ferroalloys.

(c) Ferroalloys Products

Exhibit III-4 shows that, currently, one company produces only one of the products studied, three produce two of the four products, three produce three products, and two companies produce all four.

It must be kept in mind that the manufacturing facilities have the flexibility to produce nearly all grades of all four products, and this product mix is changing constantly. The data presented reflect the 1972 situation only.

(d) Diversification

These nine companies vary widely in terms of the diversification of their products. The degree of diversification, in this case, has been defined as the percentage that ferroalloys' sales represent of total company sales. This analysis is shown in Exhibit III-5.

Shipments of ferroalloys amount to over 90% of total 1972 sales for two of the nine companies. These two companies have a combined ferroalloys employment of 1,080 which represents 13.3% of the industry work force.

Three companies with a diversification level between 20% and 89% operate eight plants and employ a work force of 2,070 or about 25.5% of the total industry employment.

Four companies are included in the "less than 20%" level of diversification. These four companies operate 11 plants which in aggregate employ 61.2% of the total industry work force.

(e) Air Pollution Control System

The nine companies producing ferroalloy products have varying air pollution control problems and equipment. Preliminary findings of the effluent guidelines study of this industry indicated that the type of air pollution system used had a definite impact on water pollution requirements and costs.

Two basic systems are employed. One uses water in some type of scrubbing operations. The other uses no water, relying primarily on baghouse filters for particulate removal.

Any water used in air pollution control systems must subsequently be treated. Exhibit III-6 lists the nine companies in coded form and the degree to which each type of system is being used.

Based on furnace capacity as measured in megawatts, 32% of the industry as a group utilize a wet system, 38% a dry system, and 30% currently have no air pollution control equipment.

Three companies have over 50% of their respective total capacities controlled by wet systems which require water treatment. Two of these are using wet systems on all of their furnaces. Four of the nine firms have 50% or more of their capacities operating on an untreated basis.

This indicates that the cost burden relating to water pollution control will differ among companies due to the use of wet versus dry systems.

TYPE OF PLANTS

The types of plants were analyzed in terms of their size, locations, and air pollution control systems.

(a) Plant Size

The best indicator of plant size in this industry is the total plant furnace capacity measured in megawatts. The available power governs the maximum output of various products. Exhibit III-7 shows the number of plants, employment, capacity, and shipments for plants in each of three size categories. It should be noted that:

1. Total industry capacity for these 22 plants is estimated to be 1,437 megawatts (mw) or about 1.4 million kilowatts. Nearly 60% of this total is in the 6 largest plants.

2. Seven plants have total capacities of less than 25 Mw. These 7 plants employ 15.2% of the work force and produced 11.5% of total industry shipments in 1972. The average capacity of plants in this group is 17 Mw; the smallest is 8 Mw.

3. The 9 plants which range in capacity from 25 Mw to 75 Mw collectively employ 1,849 workers, 22.8% of the total, and accounted for 33.7% of total industry shipments in 1972. The average capacity for these 9 plants is 54 Mw.

4. The average capacity for the six largest plants is estimated to be 138 Mw. Sixty-two percent of the industry's employees and 55% of 1972 shipments are accounted for by this group.

(b) Location

Exhibit III-8 summarizes plant data by state. Some of these data have been combined to avoid disclosure of individual plant data. In addition, Exhibit III-9 pictorially shows the locations of the 22 plants studied. These exhibits show that:

1. These 22 plants are located in 10 states, although 16 are concentrated in 4 states.

2. Six plants are located in Ohio. These plants produced $143 million in sales in 1972, 33.6% of the industry. The employees of these plants represent 42.4% of the industry. The average plant in Ohio shipped $24 million of ferroalloys.

3. Alabama has the second greatest number of plants, five. These plants are much smaller than those in Ohio and, combined, employ only 6.6% of the industry. Ferroalloy shipments totaled $51 million in 1972, or 12.0% of the industry. This is an average of about $10 million per plant.

4. Of the remaining eight states, only West Virginia and Tennessee have more than one plant.

(c) Air Pollution Control Systems

The type of air pollution control systems in use is analyzed by plant in Exhibit III-10. This provides some insight into the impact of water pollution control costs on individual plants.

Nine plants are using wet systems for controlling air pollution for at least part of their capacities. The plant total is greater than 22 since one plant often has a combination of the systems shown. These nine plants require water pollution control for treatment of the scrubber water effluent. The total capacity of these 9 plants is 575 Mw and the capacity controlled by air pollution systems using water is 463 Mw. This latter capacity is 32.2% of the total industry and about 80% of the combined capacity of these 9 plants.

EXHIBIT III-1

ENVIRONMENTAL PROTECTION AGENCY

Companies Manufacturing Selected Ferroalloys - 1973

Company	Division	Number of Ferroalloy Plants
Airco, Inc.	Airco Alloy Div.	4
Chromium Mining and Smelting Company, Ltd.	-	1
Foote Mineral Company	Ferroalloys Div.	3
Interlake, Inc.	Globe Metallurgical Div.	2
IU International Corp.	Tennessee Alloys Corp.	2
Mead Corporation	Woodward Company	2
Ohio Ferroalloys Corp.	-	2
Sandgate Corporation	Tenn-Tex Alloy Corporation	1
Union Carbide Corp.	Ferroalloys Div.	5
Total		22

Sources: Trade journals.
Dun & Bradstreet.
Moody's annual reports.
Field interviews.

EXHIBIT III-2

ENVIRONMENTAL PROTECTION AGENCY

ANALYSIS OF MANUFACTURERS OF SELECTED FERROALLOYS(1) BY CORPORATE SIZE

Corporate Size (MM)	Firms		Plants Manufacturing Selected Ferroalloys		Employees Associated with Ferroalloys Manufacturing	
	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Above $1,000	3	33.3%	9	40.9%	4,537	55.9%
$100 - $999	2	22.2	6	27.3	1,681	20.7
Less than $100	4	44.5	7	31.8	1,899	23.4
Total	9	100.0%	22	100.0%	8,117	100.0%

Note: (1) Includes only FeMn, SiMn, FeSi, and FeCr.

Sources: Field interviews.
A. T. Kearney, Inc. estimates.

EXHIBIT III-2

ENVIRONMENTAL PROTECTION AGENCY

ANALYSIS OF MANUFACTURERS OF SELECTED FERROALLOYS(1) BY CORPORATE SIZE

Corporate Size (MM)	Firms		Plants Manufacturing Selected Ferroalloys		Employees Associated with Ferroalloys Manufacturing	
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Less than $100	4	44.5	7	31.8	1,899	23.4
Total	9	100.0%	22	100.0%	8,117	100.0%

Note: (1) Includes only FeMn, SiMn, FeSi, and FeCr.

Sources: Field interviews.
A. T. Kearney, Inc. estimates.

EXHIBIT III-3

ENVIRONMENTAL PROTECTION AGENCY

ANALYSIS OF MANUFACTURERS OF SELECTED FERROALLOYS(1) BY NUMBER OF PLANTS PER COMPANY

Number of Ferroalloys Plants per Firm	Firms		Employees Associated with Ferroalloys Manufacturing		Estimated Shipments of Selected Ferroalloys(1) 1972	
	Number	Percent of Total	Number	Percent of Total	Value ($MM)	Percent of Total
1	2	22.2%	2,420	29.8%	$160	37.6%
2	4	44.5				
3	1	11.1	5,697	70.2	265	62.4
4	1	11.1				
5	1	11.1				
Total	9	100.0%	8,117	100.0%	$425	100.0%

Note: (1) Includes only FeMn, FeSi, SiMn, and FeCr.

Sources: Field interviews.
A. T. Kearney, Inc. estimates.

EXHIBIT III-4

ENVIRONMENTAL PROTECTION AGENCY

ANALYSIS OF MANUFACTURERS OF SELECTED FERROALLOYS(1) BY NUMBER OF FERROALLOYS PRODUCED

Number of Products Produced by Each Company(1)	Firms		Plants Manufacturing Selected Ferroalloys		Employees Associated with Ferroalloys Manufacturing		Estimated Shipments of Selected Ferroalloys(1) 1972	
	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Value ($MM)	Percent of Total
1	1	11.1%	1	4.5%	1,229	15.1%	$ 78	18.4%
2	3	33.3	6	27.3				
3	3	33.3	6	27.3	6,888	84.9	347	81.6
4	2	22.3	9	40.9				
Total	9	100.0%	22	100.0%	8,117	100.0%	$425	100.0%

Note: (1) Includes only FeMn, FeSi, SiMn, and FeCr.

Sources: Field interviews.
A. T. Kearney, Inc. estimates.

EXHIBIT III-5

ENVIRONMENTAL PROTECTION AGENCY

ANALYSIS OF MANUFACTURERS OF SELECTED FERROALLOYS(1) BY LEVEL OF DIVERSIFICATION

Level of Company Diversification(2)	Firms		Plants Manufacturing Selected Ferroalloys		Employees Associated with Ferroalloys Manufacturing	
	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Greater than 90%	2	22.2%	3	13.6%	1,080	13.3%
20% - 89%	3	33.3	8	36.4	2,070	25.5
Less than 20%	4	44.5	11	50.0	4,967	61.2
Total	9	100.0%	22	100.0%	8,117	100.0%

Notes: (1) Includes only FeMn, FeSi, SiMn, and FeCr.
(2) Shipments of ferroalloys as a percent of total corporate sales.

Sources: Field interviews.
A. T. Kearney, Inc. estimates.

EXHIBIT III-6

ENVIRONMENTAL PROTECTION AGENCY

ANALYSIS OF MANUFACTURERS OF SELECTED FERROALLOYS(1) BY TYPE OF AIR POLLUTION CONTROL SYSTEM

Firm	Type of Air Pollution Control System as a Percent of Furnace Capacity			
	Wet	Dry	None	Total
A	16%	55%	29%	100%
B	-	50	50	100
C	-	90	10	100
D	34	7	59	100
E	-	18	82	100
F	53	47	-	100
G	100	-	-	100
H	-	-	100	100
I	100	-	-	100
Industry Total	32	38	30	100

Note: (1) Includes only FeMn, FeSi, SiMn, and FeCr.

Sources: Field interviews.
Trade sources.
A. T. Kearney, Inc. estimates.

EXHIBIT III-7

ENVIRONMENTAL PROTECTION AGENCY

ANALYSIS OF PLANTS MANUFACTURING SELECTED FERROALLOYS(1) BY PLANT SIZE

Total Plant Furnace Capacity (Mw)	Plants Manufacturing Selected Ferroalloys		Capacity in Megawatts		Employees Associated with Ferroalloys Manufacturing		Estimated Shipments of Selected Ferroalloys(1) 1972	
	Number	Percent of Total	Mw	Percent of Total	Number	Percent of Total	Value ($MM)	Percent of Total
Less than 25	7	31.8%	121	8.4%	1,230	15.2%	$ 49	11.5%
25 to 75	9	40.9	490	34.1	1,849	22.8	143	33.7
More than 75	6	27.3	826	57.5	5,038	62.0	233	54.8
Total	22	100.0%	1,437	100.0%	8,117	100.0%	$425	100.0%

Note: (1) Includes only FeMn, FeSi, SiMn, and FeCr.

Sources: Field interviews and A. T. Kearney, Inc. estimates.

EXHIBIT III-8

ENVIRONMENTAL PROTECTION AGENCY

ANALYSIS OF PLANTS MANUFACTURING SELECTED FERROALLOYS(1) BY LOCATION

Location	Plants Manufacturing Selected Ferroalloys(1) Number	Plants Manufacturing Selected Ferroalloys(1) Percent of Total	Employees Associated with Ferroalloys Manufacturing Number	Employees Associated with Ferroalloys Manufacturing Percent of Total	Estimated Shipments of Selected Ferroalloys 1972 Value ($MM)	Estimated Shipments of Selected Ferroalloys 1972 Percent of Total
Ohio	6	27.3%	3,439	42.4%	$143	33.6%
Alabama	5	22.7	539	6.6	51	12.0
Kentucky	1	18.2	1,559	19.2	96	22.6
Tennessee	3					
New York	1	31.8	2,580	31.8	135	31.8
South Carolina	1					
Texas	1					
West Virginia	2					
Oregon	1					
Washington	1					
Total	22	100.0%	8,117	100.0%	$425	100.0%

Note: (1) Includes only FeMn, FeSi, SiMn, and FeCr.

Sources: Field interviews and A. T. Kearney, Inc. estimates.

EXHIBIT III-9

ENVIRONMENTAL PROTECTION AGENCY
LOCATIONS OF FERROALLOY PLANTS PRODUCING
FeMn, FeSi, FeCr, AND SiMn IN
THE UNITED STATES

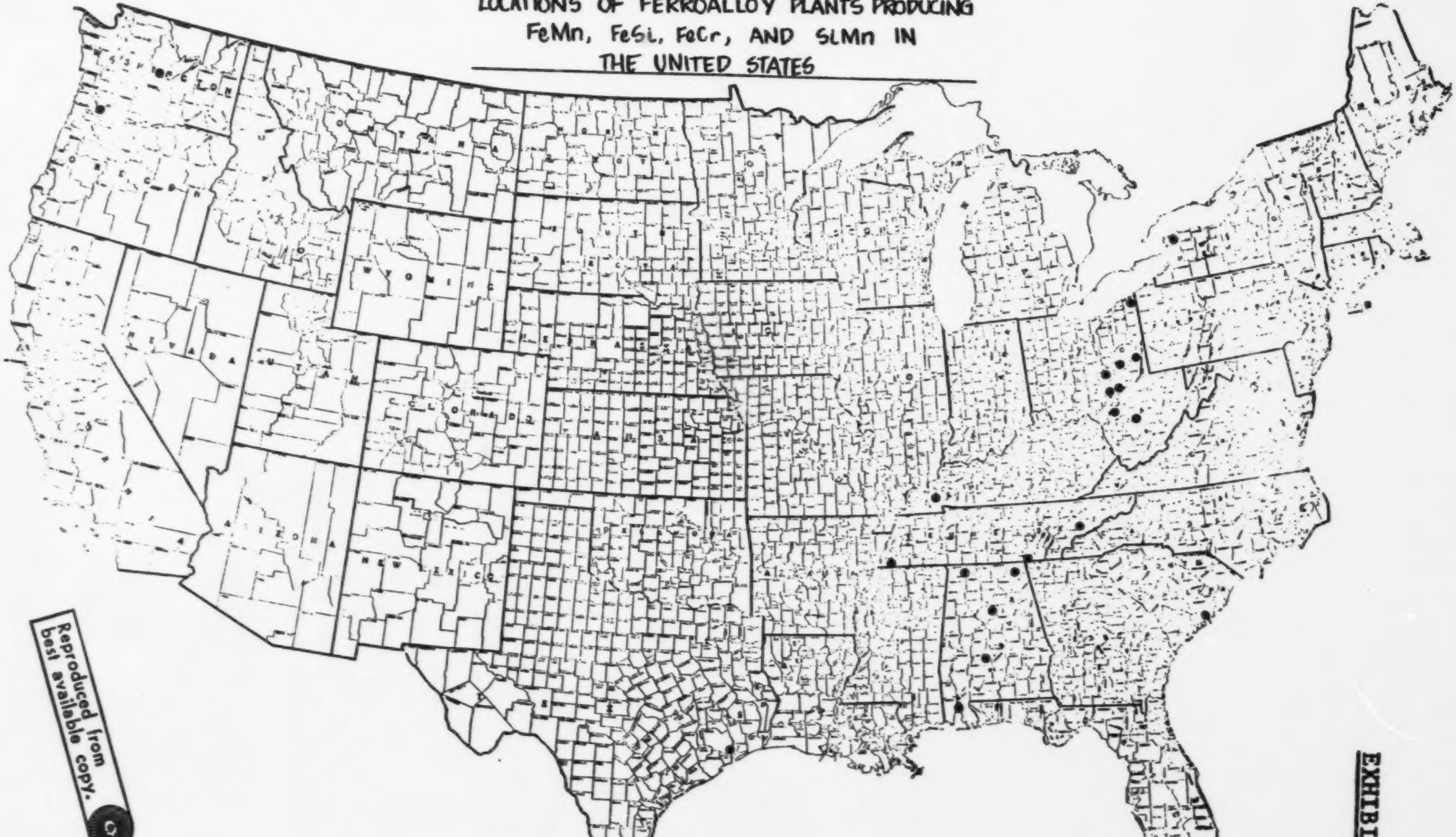

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EXHIBIT III-10

ENVIRONMENTAL PROTECTION AGENCY

ANALYSIS OF PLANTS MANUFACTURING SELECTED FERROALLOYS(1) BY FURNACE TYPE AND AIR POLLUTION CONTROL SYSTEM

Type of Furnace and Air Pollution Control System	Plants Manufacturing Selected Ferroalloys(1)		Estimated Furnace Capacity		Number of Firms with This Type of System
	Number(2)	Percent of Total	Megawatts	Percent of Total	
Open Furnace - Wet A/P System	3	10.7%	463	32.2%	3
Closed Furnace - Wet A/P System	6	21.4			4
Open or Closed - Dry A/P System	10	35.7	542	37.7	6
Open or Closed - No A/P System	9	32.2	432	30.1	5
Total	28(2)	100.0%	1,376	100.0%	18

Notes: (1) Includes only FeMn, FeSi, SiMn, and FeCr.

(2) Total is greater than 22 since one plant may have more than one system.

Sources: Field interviews and A. T. Kearney, Inc. estimates.

IV - FINANCIAL CHARACTERISTICS OF THE INDUSTRY

Financial data on individual plants of the ferroalloys industry are extremely limited due to the fact that:

1. A large number of ferroalloy plants are operated by divisions of widely diversified companies which do not provide either divisional or individual plant data.

2. Firms with a higher degree of specialization operate numerous plants on which only consolidated data are published.

3. Trade literature and relevant statistics provide rather sketchy or obsolete data on individual plants.

As a result, it is not possible to establish valid and meaningful financial profiles for individual plants in the ferroalloys industry. Relevant insights into the financial background of the industry may be gained, however, by analyzing the available data of the companies as provided in their annual reports and in other sources. This information should be sufficient to judge the profitability and financial strength of the companies involved and therefore their capability to finance investments necessary for the abatement of water pollution.

The topics listed on the following page are described in this section, based on data obtained from company annual reports, from Moody's Industrial Manual and from sources within individual companies:

- Sizes of companies
- Profitability and capital availability

- Cost structure
- Salvage value of assets.

Cash flow, although specified in Task Order No. WA-73X-415, will not be discussed because it has not been possible to obtain the necessary data.

SIZES OF COMPANIES

Exhibit IV-1 shows the broad range in size of the companies producing and selling selected ferroalloys in terms of net sales volume of all products being produced and sold by these companies. This exhibit demonstrates the following:

1. Three companies each had total sales in excess of $1 billion in 1972 and 1973. In combination they had total 1972 sales in excess of $5 billion, and in 1973 combined sales exceeded $6.5 billion.

2. Two companies in the medium total sales bracket ($100 to $999 million) had combined sales of $880 and $1,044 million in 1972 and 1973 respectively.

3. Four companies, each with total sales under $100 million, had combined sales of $197 and $182 million in 1971 and 1972, respectively. In 1973, three companies had combined sales of $182 million.

4. About the same relationship shown for combined net sales exists for the value of total assets controlled by each of the three groups of companies.

These data and more detailed information, the confidentiality of which precludes disclosure, indicates that this industry is not concentrated in any particular corporate size group. It is broadly distributed among the three groupings defined by total 1972 corporate sales.

Exhibit IV-2 shows that there is a wide range in the degree of diversification between the nine companies producing selected ferroalloys. It also shows the following:

1. There are only two companies which specialize in ferroalloy production and have over 90% of sales dollars in this market. Their conbined sales in 1972 amounted to about $72 million, which represents about 17% of the estimated total market volume of $425 million served by the domestic industry.

2. Three less specialized firms have combined ferroalloy sales in the range of 20%-90% of total sales. Their combined ferroalloy sales amounted to about $135 million in 1972. This represents about 32% of the estimated total market served by the domestic industry, and about 22% of their combined total sales. This latter percentage is not shown in Exhibit IV-2, but was derived from a separate analysis.

3. The group of four diversified corporations has the dominant share of the market served by domestic producers of selected ferroalloys, about 51%, but this amounts to only about 4% of their combined 1972 net sales for all products.

4. In combination, the seven companies which are diversified controlled in 1972 over 83% of the market of

selected ferroalloys served by domestic manufacturers, but this, on the average, amounted to only a small part of their combined total net sales.

5. The combined assets of the four most highly diversified large companies were almost $6.2 billion in 1971. This is over 100 times greater than those of the specialized firms and 8 times greater than those of the middle group.

The data in Exhibits IV-1 and IV-2 have demonstrated wide ranges in total size and in degree of diversification for the nine companies producing the selected ferroalloy products. Yet, similarities exist in the way in which they will view the capital expenditures for water pollution control equipment:

1. For the smaller, highly specialized companies this might be a question of being able to stay in business.

2. For the larger, highly diversified corporations it might be a question of carrying on a line of business which eventually would not meet their goals of return on sales and investment.

PROFITABILITY AND CAPITAL AVAILABILITY

(a) Profitability

Exhibit IV-3 presents the profit ratios achieved by the companies grouped according to their amount of total net sales, which is the same grouping used in Exhibit IV-1.

1. Return on sales and on assets after taxes were highest for the large companies in 1972 and 1973, and lowest

for the small companies. The differences in these ratios are substantial. Return on sales in 1972 for the large company group was almost 200% above that for the medium-size companies, while the small company group operated at a loss. Results in 1973 show the small companies operating just behind the medium size group.

2. The return on shareholders' equity after taxes follows a similar pattern to returns on sales and assets. In 1972, the large company group achieved a return equal to the average shown in Fortune's listing of the industry medians of the "first 500."(1) However, the medium-sized company group showed a poorer performance and the grouping of small companies suffered a negative return on equity. In 1973 the large company group outperformed the "first 500" by more than 15%.(2)

3. The profit ratios after taxes for the group of medium-sized companies were distinctly lower in 1972 than in 1971, while the group of small companies incurred a loss in 1972 versus small profits in 1971. This development can be attributed partially to the price cutting in 1972 which took place in response to increased volume of imported ferroalloy products. In 1973 these two groups performed about equally.

Compared to the results listed in Fortune for the "first 500," the return on sales for the group of large-sized companies would, in 1971, fit somewhat above the middle of the listed industries and in 1972 just at the bottom of the top one-third. The highest returns on sales in 1971 and 1972 were achieved by the mining industry, 12.8% and 11.6% respectively. The lowest returns were reported by the food industry, 2.2% and 2.5% respectively. In 1973, the large-sized companies nearly equalled the mining industry, again the leader with a 14.6% return on sales.

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(1) "Who Did Best (and Worst) Among the 500," Fortune, May, 1973, Page 244.

(2) "The Fortune Directory," Fortune, May, 1974, Page 231.

While Exhibit IV-3 shows that the larger corporations achieve better profit ratios than the smaller ones, this cannot be generalized as typical for all of the smaller companies. Exhibit IV-4 shows the distribution of profit ratios in the various groups according to their degree of diversification. This is the same grouping used in Exhibit IV-2. In 1971, the group of specialized producers, which are also smaller companies, achieved remarkably better results than the two groups of diversified companies. For instance, in 1971 the ratio of net return to net sales for the specialized companies was about 20% above that of the highly diversified companies and somewhat more than 40% above the ratio of the medium group.

As shown in Exhibit IV-4, however, the profit ratios for the group of specialized firms declined significantly in 1972 and the medium group even incurred a loss. This is mainly the result of the problems the industry went through with rising ferroalloy imports in 1972. This brought about price competition and under-utilized production capacities.

This is substantiated by Exhibit IV-5 which shows for each of three diversified companies the following data for 1970, 1971 and 1972:

1. Sales of ferroalloys as a percentage of total sales of all products remained nearly constant.

2. Gross earnings for ferroalloys as a percentage of gross earnings for all products dropped sharply in 1972.

3. Gross earnings from ferroalloy products as a percentage of ferroalloy sales also dropped sharply in 1972.

Exhibit IV-6 shows, on the other hand, that the profit decline in 1972 was a rather unique experience for the highly specialized producers in the ferroalloy industry. While returns on net sales, on assets and on shareholders' equity were fluctuating somewhat between 1963 and 1971, there was a major decrease in 1972. This exhibit also shows remarkable differences in return between one company which is diversified to a certain degree and two companies with practically all of their sales in ferroalloys. In 1971, the latter two companies were ahead of the industry medians as listed in Fortune's "Second 500."(1) They dropped into the lower third of the listing in 1972. The somewhat more diversified company was in the second third in 1971 and dropped to the bottom in 1972. In 1973, the performance of these companies placed them at the bottom of the middle third with respect to both return on sales and on stockholders equity.(1)

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(1) Who Did Best (and Worst) Among the Second 500," Fortune, June, 1973, Page 176.

From the foregoing, it may be concluded that profit characteristics and profit developments of the companies involved in the production and sales of ferroalloys indicate:

1. Profits have not been specifically depressed within the industry, except in 1972, and should usually be at least as high as the average profit ratios for all U.S. industry.

2. Profits vary according to level of ferroalloy imports. A high level of imports results in price competition, which, in turn, results in lower profits.

3. Profits vary significantly with the variations in rate of capacity utilization.

(b) Capital Availability

Exhibits IV-7 and IV-8 show the current ratios (current assets to current liabilities) and the ratios for current liabilities and for long-term debt to equity for groups of companies again arranged according to sales volume and degree of diversification. These data may give some impression of capital structure and capital availability but offer little insight into the financial strengths or weaknesses of the individual operating units since they are derived from consolidated balance sheets. On the other hand, providing equipment for the abatement and control of water pollution alone, if it has not been installed already, is expected by the industry to require only a moderate capital investment. Thus, the amounts involved are not expected to pose a question of capital availability for any one of the companies involved in this study.

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(1) "Who Did Best (and Worst) Among the Second 500," Fortune, June, 1974, Page 182.

COST STRUCTURE

Exact data necessary to analyze the cost structure of individual plants or companies are not available. An analysis of the cost structure is complicated, not only by the lack of data, but also by the complex nature of most companies whose sales in ferroalloys are only a minor part of their total sales.

Field sources generally stated the following rough structure of operating costs as being fairly representative for the industry:

- Labor about 18%-22%.
- Power about 20%-25%.
- Supplies and raw materials about 60%.

The main bulk of operating costs, therefore, is connected with the costs of ore and other supplies. This is followed by the cost of power, which in some instances has risen considerably in recent years. Labor costs are third, about equal to or somewhat lower than the cost of power.

The percentage figures cited for the operating costs will vary with the kind of products produced and the size and type of equipment used. However, they may serve as a helpful device for assessing the economic impacts of costs for the abatement and control of water pollution.

SALVAGE VALUE OF ASSETS

Reliable estimates of the market or salvage value of fixed assets of individual plants could not be obtained. These values would have mainly a theoretical importance, since, according to field sources, no plant would be closed because of the costs involved with the abatement of water pollution alone.

Generally, the salvage value of assets can be estimated at least as the working capital required to operate the plant, which should be totally recoverable, and the site value. The plant equipment itself is highly specialized for the technical process of producing ferroalloys, so that only a fractional part (that is, the scrap value) of the capital value could be realized on the market. Office buildings and warehouses are more easily and profitably sold, depending on their age, location and equipment.

EXHIBIT IV-1

ENVIRONMENTAL PROTECTION AGENCY

SIZE OF COMPANIES IN THE FERROALLOYS INDUSTRY BY DOLLAR SALES(1)

			All Products				Estimated Shipments of Selected Ferroalloys		
Value of Net Sales ($MM)	Year	Number of Companies ($MM)	Combined Net Sales ($MM)	Combined Assets ($MM)	Combined Profits before Taxes ($MM)	Combined Profits after Taxes ($MM)	Value(2) ($MM)	Percentage	Sale of Selected Ferroalloys as Percentage of Total Sales
Above $1,000	1971	3	$5,159	$5,830	$400(3)	$228	n.a.	n.a.	n.a.
	1972	3	5,582	6,113	496(3)	280	$178	41.9%	3.1%
	1973	3	6,786	6,772	n.a.	414	n.a.	n.a.	n.a.
$100 - $999	1971	2	763	932	53	32	n.a.	n.a.	n.a.
	1972	2	880	959	49(4)	15	132	31.1	14.8
	1973	2	1,044	953	61	36	n.a.	n.a.	n.a.
Under $100	1971	4	197(5)	212	13(3)(4)	5	n.a.	n.a.	n.a.
	1972	4	182(6)	197(7)	(3)(8)	(10)(7)(8)	115	27.0	65.9
	1973	4	182(9)	172(9)	n.a.	6(9)	n.a.	n.a.	n.a.
						1972 Totals	$425	100.0%	

Notes:
(1) Balance and income sheet data from annual reports and Moody's.
(2) Estimated value of shipments.
(3) For one company, the data are estimated.
(4) For one company, extraordinary item is omitted.
(5) For one company, sales of foreign holding company are included. For another company, rental revenues are included.
(6) Excluding foreign holding company of one company, including rental revenues of one company.
(7) For one company the data are not available; for comparative purposes, 1971 figure is included.
(8) Profits of one company are not available. Loss occurred mainly outside the ferroalloys.
(9) For three companies only.

EXHIBIT IV-2

ENVIRONMENTAL PROTECTION AGENCY

DEGREE OF DIVERSIFICATION OF COMPANIES IN THE FERROALLOYS INDUSTRY BY ESTIMATED PERCENTAGES OF SALES IN SELECTED FERROALLOYS(1)

Degree of Diversification by Sales of Selected Ferroalloys as Percentage of All Sales	Year	Number of Companies	Estimated Shipments in Selected Ferroalloys		All Products			
			Value ($MM)	Percentage	Combined Net Sales ($MM)	Combined Assets ($MM)	Combined Profits before Taxes ($MM)	Combined Profits after Taxes ($MM)
Above 90%	1971	2	n.a.	n.a.	$ 76(2)	$ 59(2)	$ 8(2)(3)	$ 4(2)
	1972	2	$ 72	16.9%	72	41(4)	1(4)	1(4)
	1973	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
20% - 90%	1971	3	n.a.	n.a.	532(5)	731	37(6)	20(5)
	1972	3	135	31.8	609(5)	743	23(7)	(9)
	1973	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Under 20%	1971	4	n.a.	n.a.	5,511	6,179	421(3)	241
	1972	4	218	51.3	5,970	6,465	518(3)	293
	1973	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
		1972 Totals	$425	100.0%				

Notes:
(1) Balance and income sheet data from annual reports and Moody's.
(2) For one company, data of foreign holding company are included.
(3) For one company, data are estimated.
(4) Data for one company are not available.
(5) Rental revenues for one company are included.
(6) For one company, profit from rental revenue is included; for a second company, profits are estimated.
(7) For one company, extraordinary item is omitted.

EXHIBIT IV-3

ENVIRONMENTAL PROTECTION AGENCY

PROFIT RATIOS BY SIZE OF COMPANY IN THE FERROALLOYS INDUSTRY

Value of Net Sales ($MM)	Year	Number of Companies	Return on Sales		Return on Assets		Return on Shareholders' Equity	
			Before Taxes	After Taxes	Before Taxes	After Taxes	Before Taxes	After Taxes
Above $1,000	1971	3	7.8%	4.4%	6.9%	3.9%	14.9%	8.5%
	1972	3	8.9	5.0	8.1	4.6	17.7	10.0
	1973	3	n.a.	6.1	n.a.	6.1	n.a.	14.5
$100 - $999	1971	2	6.9	4.2	5.6	3.3	11.1	6.7
	1972	2	5.6	1.7	5.1	1.6	10.5	3.2
	1973	2	5.9	3.4	6.4	3.8	12.8	7.8
Under $100	1971	4	6.6	2.5	6.1	2.4	10.3	4.0
	1972	4	(1.7)	(5.5)	(1.5)	(5.1)	(2.7)	(9.2)
	1973	4	n.a.	3.3*	n.a.	3.5*	n.a.	7.4*

Notes: * For three companies only

Sources: Exhibit IV-1, 19 annual reports and Moody's.

EXHIBIT IV-4

ENVIRONMENTAL PROTECTION AGENCY

PROFIT RATIOS OF COMPANIES BY DEGREE OF DIVERSIFICATION IN THE FERROALLOYS INDUSTRY

Degree of Diversification by Sales of Selected Ferroalloys as Percentage of All Sales	Year	Number of Companies	Return on Sales		Return on Assets		Return on Shareholders' Equity	
			Before Taxes	After Taxes	Before Taxes	After Taxes	Before Taxes	After Taxes
Above 90%	1971	2	10.5%	5.3%	13.6%	6.8%	21.0%	10.5%
	1972	2	1.6	1.6	2.4	2.4	3.3(1)	3.3(1)
	1973	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
20% - 90%	1971	3	6.9	3.8	2.7	2.7	10.4	5.6 (2)
	1972	3	3.8	(1.5)	(1.2)	(1.2)	6.8	(2.7)
	1973	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Under 20%	1971	4	7.6	4.4	3.9	3.9	14.5	8.3
	1972	4	8.7	4.9	4.5	4.5	17.2	9.7
	1973	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Notes: (1) Data for only one company are available.
(2) For comparative purposes one company's 1971 equity data are also used for 1972 since recent data are not available.

Sources: Exhibit IV-2, annual reports, and Moody's.

EXHIBIT IV-5

ENVIRONMENTAL PROTECTION AGENCY

SALES AND GROSS EARNINGS RELATIONSHIPS OF DIVERSIFIED COMPANIES

Company	Year	Sales of Ferroalloys as Percentage of All Sales	Gross Earnings in Ferroalloys as Percentage of All Gross Earnings	Gross Earnings as Percentage of Ferroalloys Sales
A	1970	n.a.	n.a.	n.a.
	1971	6.9%	17.7%	18.5%
	1972	6.0	5.0	5.8
	1973	n.a.	n.a.	n.a.
B	1970	n.a.	n.a.	n.a.
	1971	25.2	27.0	12.5%
	1972	26.2	8.8	3.0
	1973	n.a.	n.a.	n.a.
C	1970	81.9	89.7	10.9%
	1971	81.6	88.8	9.0
	1972	79.0	38.0	1.6
	1973	n.a.	n.a.	n.a.

Sources: Annual company reports and Moody's.

EXHIBIT IV-6

ENVIRONMENTAL PROTECTION AGENCY

DEVELOPMENT OF PROFIT RATIOS FOR HIGHLY SPECIALIZED FERROALLOYS PRODUCERS

	Return on Net Sales						Return on Assets						Return on Shareholders' Equity					
	Before Taxes			After Taxes			Before Taxes			After Taxes			Before Taxes			After Taxes		
	Company			Company			Company			Company			Company			Company		
Year	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
1963	5.9%	n.a.%	n.a.%	3.4%	n.a.%	n.a.%	6.6%	n.a.%	n.a.%	3.9%	n.a.%	11.1%	6.6%	n.a.%	n.a.%	3.9%	n.a.%	n.a.%
1967	4.9	11.4	12.6	3.1	6.7	8.4	3.8	16.1	18.3	2.4	9.5	12.2	4.9	19.8	30.5	3.1	11.7	20.2
1968	3.7	9.5	n.a.	3.5	3.7	n.a.	2.7	12.9	n.a.	2.6	6.6	n.a.	3.7	16.1	n.a.	3.5	8.2	n.a.
1969	5.5	11.5	n.a.	3.2	5.6	n.a.	4.6	15.8	n.a.	2.7	7.8	n.a.	6.3	21.0	n.a.	3.7	10.3	n.a.
1970	6.4	12.1	n.a.	3.8	6.5	n.a.	5.6	18.0	n.a.	3.3	9.6	n.a.	7.7	23.7	n.a.	4.7	12.7	n.a.
1971	4.1	10.6	9.2	0	5.8	5.4	3.3	14.5	10.4	0	7.9	6.1	4.7	18.1	27.0	0	9.9	16.0
1972	0.0	2.7	n.a.	(6.9)	1.9	n.a.	0.0	3.5	n.a.	(6.5)	2.5	n.a.	0.0	4.6	n.a.	(8.7)	3.3	n.a.
1973	4.1	n.a.	n.a.	3.3	3.4	n.a.	4.0	n.a.	n.a.	3.2	4.6	n.a.	6.0	n.a.	n.a.	4.8	10.8	n.a.

Note: Company A derives about 80% of its revenue from the sales of ferroalloys, Company B 100%. Data for Company B are derived from consolidated balance and income sheet data of foreign holding company which operates a wholly-owned U.S. subsidiary and produces mainly ferroalloys. Profit before taxes for one company in 1972 excludes extraordinary losses.

Sources: Annual company reports and Moody's.

EXHIBIT IV-7

ENVIRONMENTAL PROTECTION AGENCY

CAPITAL STRUCTURE BY SIZE OF COMPANY IN DOLLAR SALES

Annual Sales ($ Millions)	Year	Number of Companies	Current Ratio	Current Liabilities to Equity	Long-Term Debt to Equity
Above $1,000	1971	3	2.2	37.1%	62.1%
	1972	3	2.1	38.2	61.5
	1973	3	2.5	43.8	58.9
$100 - $999	1971	2	3.6	21.9	54.7
	1972	2	2.7	32.6	52.1
	1973	2	2.9	29.5	47.4
Under $100	1971	4	2.3(1)	32.1	31.9
	1972	4	2.6(2)	25.7(2)	5.7(2)
	1973	4	2.2(2)	41.3(2)	8.2(2)

Notes: (1) For one company this includes lease contracts, revenue equipment.
(2) For three companies.

Sources: Annual company reports and Moody's.

EXHIBIT IV-8

ENVIRONMENTAL PROTECTION AGENCY

CAPITAL STRUCTURE BY DEGREE OF SPECIALIZATION OF THE COMPANIES IN THE FERROALLOYS INDUSTRY

Degree of Diversification by Sales of Ferroalloys as Percentage of All Sales	Year	Companies	Current Ratio	Current Liabilities to Equity	Long-Term Debt to Equity
Above 90%	1971	2	2.0	37.6%	16.8%
	1972	2	2.7(1)	24.7(1)	4.7(1)
	1973	N.A.	N.A.	N.A.	N.A.
20% - 90%	1971	3	4.8(2)	21.9	62.4
	1972	3	2.8(3)	33.3(3)	54.1(3)
	1973	N.A.	N.A.	N.A.	N.A.
Under 20%	1971	4	2.1	36.2	60.1
	1972	4	2.2	37.6	59.5
	1973	N.A.	N.A.	N.A.	N.A.

Notes:
(1) Only one company.
(2) For one company this includes lease contracts, revenue equipment.
(3) Only two companies.

Sources: Annual company report and Moody's.

V- PRICE EFFECTS

The Ferroalloys Industry is highly competitive both domestically and internationally. For a given ferroalloy, there is very little product differentiation among producers. Consequently, ferroalloys are traded as commodities, and prices, therefore, are determined by market conditions.

In assessing the competitive nature of these markets, all producers of the selected ferroalloys must be considered. This includes captive establishments and foreign producers with export capacity, as well as all producers utilizing processes other than electrothermic. Given the types of products, number of producers, and entry conditions in the world market, this market is approximately analyzed in a competitive framework. Specifically, total free world production is of sufficient quantity and the absence of product differentiation leads to competitive pressures on prices so that they approach production and transportation costs (including a competitive rate of return) over the long-run.

The markets are organized, transactions occur frequently and price information is not only available but is periodically published. Short run pricing tends to reflect short run demand conditions in relation to capacity.

Producers operate independently of one another and sales are not concentrated among a few producers. Although the four largest producers included in this study possess about 80% of the total megawatt capacity of all the firms studied, the concentration ratios for individual products, relative to the total market for each product, are much less. Thus market concentration and related market power is much less. Competitive pressure is exerted by the ability of firms to enter new product markets when they have already established capacity in the industry. Raw materials are available to all producers on the world market. Purchases are made by many firms. In the United States alone, there are more than 160 firms engaged in steel making and over 1,600 ferrous foundries.

Price adjustments over time, reflecting the market pressures of changing conditions are displayed in Exhibit V-1. This exhibit shows that prices have risen despite declining consumption. Also, prices have remained constant or experienced only slight increases in periods of appreciable increases in consumption. This behavior is consistent with a competitive framework.

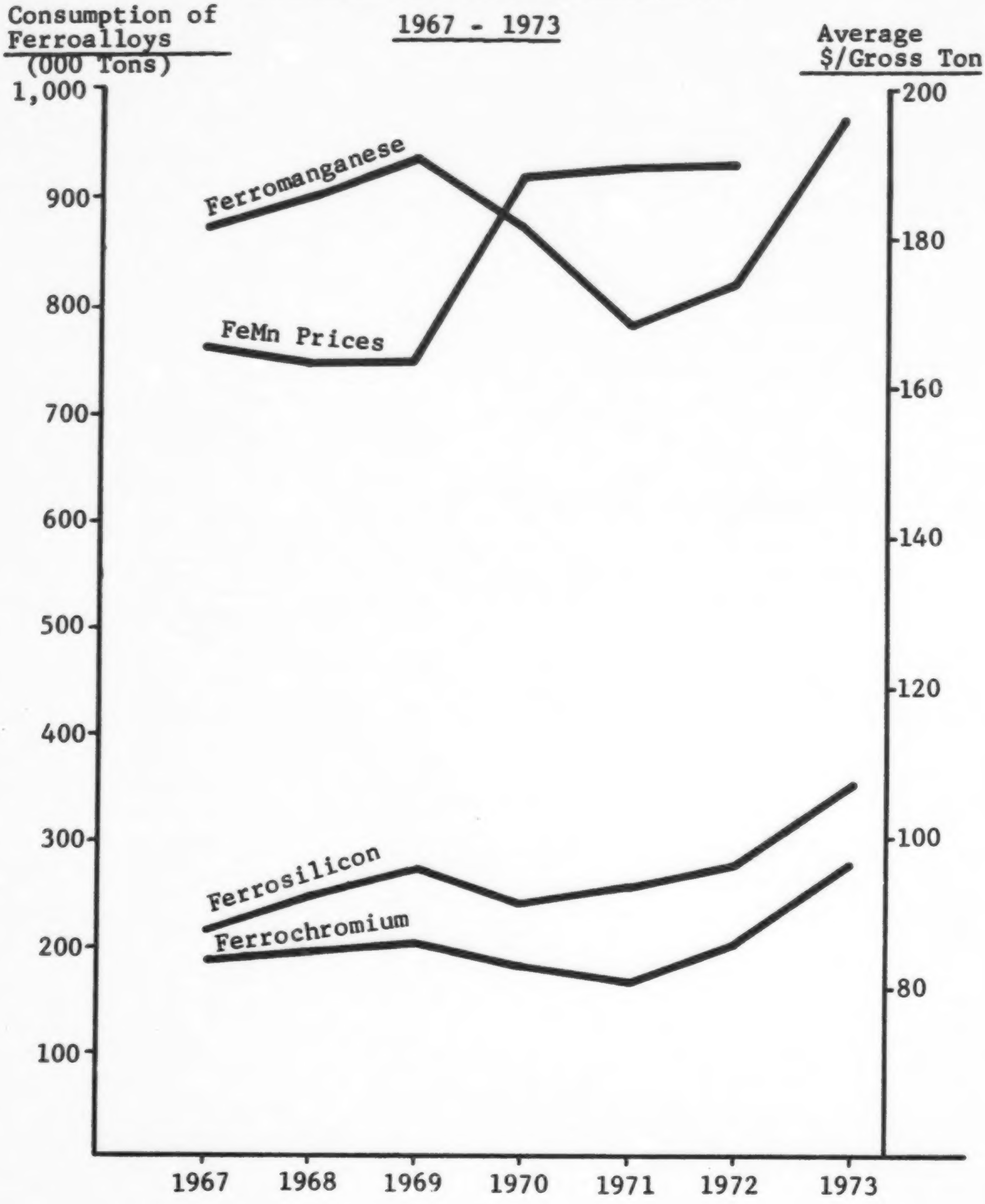
Given the competitive nature of the ferroalloy market, it is unlikely that prices can be increased in the short-range, to recover pollution control costs due to the current pressures of imports. In the long-range, if these costs are significant, to the extent that domestic producers remain competitive with imports, pollution control costs will be passed on to users of ferroalloys in the form of price increases. It can be noted that foreign producers are also beginning to experience higher pollution control costs.

v-4

EXHIBIT V-1

CONSUMPTION AND PRICES OF SELECT FERROALLOYS - BY YEAR

1967 - 1973



Source: AISI
American Metal Market's
Metal Statistics

VI - METHODOLOGY OF IMPACT ASSESSMENT

The following methodology was used in assessing the economic impact of the cost of water pollution control on the ferroalloys industry:

1. The analysis was based on the 1972 industry level of sales. This is reasonable since:
   - (a) Historical industry growth has been minimal.
   - (b) The relationship of additional costs to additional sales will be relatively constant.
2. The cost data used, supplied by Datagraphics, Inc. are based on August, 1971 cost levels.
3. The financial impact on the industry as a whole was measured in terms of the effect on the industry's average profit before taxes as a percent of sales and the effect on average profit before taxes as a percent of total assets.
4. The same analyses were performed on groups of companies with various levels of usage of wet air pollution control equipment.
5. The impact on prices of ferroalloys was determined based on maintaining the industry's historical average level of profitability before taxes. This was done for three measures of profitability:
   - (a) Maintenance of the same dollar value of profits before taxes.
   - (b) Maintenance of the same profit level before taxes measured in terms of "profit as a percent of sales."

(c) Maintenance of the same profit level before taxes measured in terms of "profit as a percent of total assets."

6. The impact on production curtailment, plant closings, etc. was based on:

(a) Judgmental assessment of the expected financial impact.

(b) Interviews with industry sources.

(c) Evaluation of the level of additional investment required by company.

VII - IMPACT ANALYSIS

The data presented in preceding sections indicate that the impact of water pollution control costs will be minimal for this industry. Of greater importance to the industry is the impact of air pollution control costs and imports which have seriously affected both the industry's growth and profitability in recent years.

Because of this limited impact, it was decided by A. T. Kearney and the EPA that a general analysis of the industry, rather than a detailed analysis of industry segments, would be sufficient to provide the assessment of the impact on the ferroalloys industry.

It should be noted that since the original assessment of the economic impact of water pollution abatement costs, the effluent guidelines have been modified. The current standards no longer concern themselves with noncontact cooling water. The results discussed later in this section have not been changed to reflect this modification. The effects of these changes would be of the following order of magnitude for furnaces with wet air pollution control devices. For 1977, investment costs per megawatt would decrease about 7% and annual ownership and operating costs would decrease about 33% per megawatt. For 1983 these reductions would be 29% and 33% respectively.

INVESTMENT AND OPERATING COSTS

Cost data reported in August, 1971 dollars for various treatment levels were developed by Datagraphics, Inc. as part of an analysis of the industry' effluent requirements. These data are summarized in Exhibits VII-1, VII-2, and VII-3. These exhibits show the investment requirements for water pollution abatement per megawatt of furnace capacity and the related operating costs per megawatt per day. Exhibit VII-1 contains the data regarding equipment necessary to meet the 1977 standards (BAT): Exhibit VII-2, the 1983 standards (BPT); and Exhibit VII-3, new source standards.

The industry costs developed in the remainder of this report are based on these data and are therefore expressed in August, 1971 dollars. Furthermore, it is the incremental costs required to meet the industry standards that have been analyzed, not the total capital costs. Note that the new source requirements call for new plants with open furnaces to utilize a dry air pollution control system. Closed furnaces may use either a wet or dry system.

CURRENT INDUSTRY FACILITIES

The projected impact on the ferroalloys industry is related to the type of air pollution control systems in use and the amount of water treatment equipment already installed.

(a) Type of Air Pollution System

It has been shown that the two sources of water pollution are furnace cooling water and water used in wet-type air pollution control systems. Table VII-1 shows that, currently, 32.2% of the industry's furnace capacity is equipped with wet-type air pollution systems.

Table VII-1

Existing Air Pollution Control Facilities in the Ferroalloys Industry

Type of System	Furnace Capacity (Mw)	Percent of Total
Wet Air Pollution Control Systems	463	32.2%
Dry Air Pollution Control Systems	542	37.7
No Air Pollution Control Systems	432	30.1
Total	1,437	100.0%

Source: Exhibit III-10.

As was shown in Exhibit VII-1, the investment cost for water pollution control to meet the 1977 standards was estimated to be $18,409 per megawatt for an open furnace with a wet air pollution control system, $23,488 per megawatt for a closed furnace with a wet system, and $1,266 per megawatt for dry air pollution systems. In 1983, the requirements are $29,507 per megawatt for an open furnace with a wet system, $35,747 for a closed furnace with a wet system and $8,444 for dry systems.

It is significant that the industry is currently using wet air pollution control systems for only 32.2% of its capacity, since the investment costs associated with these systems are about four times as great as those for the dry air pollution control systems. Because of this, manufacturers in this industry who currently have no air pollution control (30.1% of industry capacity) are planning to install dry systems.

(b) Existing Wastewater Treatment Facilities

The 1983 standards require the recirculation of furnace cooling water through cooling towers plus treatment of the blowdown. Many plants already are using cooling towers for the recirculation of this cooling water but are not treating the blowdown in accordance with the proposed standards. If these plants also have dry air pollution control systems, these existing facilities will meet 1977 standards. The additional investment required to meet 1983 standards will be $1,333 per megawatt.

This is projected to result in additional annual operating costs of $4.66 per megawatt-day.

The following table shows the extent to which existing facilities already meet the 1977 standards, (BAT).

Table VII-2

Existing Industry Wastewater Treatment Facilities

	Plants		Furnace Capacity	
	Number	Percent of Total	Mw	Percent of Total
Meets All 1977 Requirements	14	63.6%	1,012	70.4%
Requires Additional Facilities To Meet 1977 Requirements	8	36.4	425	29.6
Total	22	100.0%	1,437	100.0%

Fourteen of the 22 plants, representing over 70% of the industry's capacity, already have in operation the equipment necessary to meet the 1977 standards. It has been assumed, based on interviews with industry manufacturers, that all uncontrolled plants will install dry air pollution control systems. Therefore, the 1977 standards will impose additional costs on the industry for only about 30% of its total capacity. The total costs to the industry are discussed in the following paragraphs.

INDUSTRY COST REQUIREMENTS

(a) Investment Costs

Table VII-3 on the following page shows the additional investment required for the industry to meet the effluent standards for 1977 and 1983: $9.5 million and $6.2 million, respectively, for a total of $15.7 million. It is assumed that these costs include the acquisition of land when and as needed. It is estimated that industry total assets are currently about $404 million. Thus, the additional investment required by 1983 to meet water pollution control standards is estimated to be about 3.9% of the industry's present total assets.

Table VII-3

Additional Investment Required To Meet 1977 and 1983 Effluent Standards

	Number of Plants	Capacity (Mw)	Additional Investment 1977 (000)	1983 (000)	Total (000)
	14	1,012	-0-	$1,201	$ 1,201
	8	425	$9,489	5,041	14,530
Total	22	1,437	$9,489	$6,242	$15,731

Source: A. T. Kearney, Inc.

(b) Annual Ownership and Operating Cost

Table VII-4 shows the total industry annual cost increase due to the addition of the equipment required to meet the proposed 1977 water pollution standards.

Table VII-4

Increase in Ownership and Operating Costs 1977 Standards versus Current Costs

	Number of Plants	Capacity (Mw)	Annual Cost Increase (000)
	14	1,012	-0-
	8	425	$4,034
Total	22	1,437	$4,034

Source: A. T. Kearney, Inc.

The total for the industry is estimated to be about $4.0 million, but 14 plants will have no cost increase at all. This cost increase represents 0.95% of current industry sales ($425 million).

Table VII-5 shows that the 1983 standards will impose additional costs on the industry. The costs are projected to be $8.2 million greater than current industry costs, or 1.94% of current industry sales.

Table VII-5

Increase in Ownership and Operating Costs
1983 Standards versus Current Costs

	Number of Plants	Capacity (Mw)	Annual Cost Increase (000)
	14	1,012	$1,532
	8	425	6,694
Total	22	1,437	$8,226

Source: A. T. Kearney, Inc.

INDUSTRY PRICE EFFECTS

This section discusses the impact these added costs will have on the price of ferroalloys. In Section V it was reported that:

1. The ferroalloys industry is very competitive.
2. Ferroalloys are commodity-type products with little production differentiation.
3. Imports are significant and have a major impact on prices.

Because of these facts, market conditions are the major determinants of prices in this industry. Annual price fluctuations can amount to 5% or more of the average. It will be shown that the added costs for water pollution control are relatively small. Although it is unlikely that these cost increases can be immediately passed on in the form of price increases, it is expected that these costs will eventually be recovered through increased prices.

The projected cost increases for 1977 and 1983 are reviewed in the following paragraphs.

(a) 1977 Standards (BAT)

Exhibit VII-4 shows that the total industry costs for water pollution control, based on 1977 requirements, amount to about $4.0 million annually. If the industry attempts to maintain the same profit level, in dollars, a 0.95% price increase will be required. If the industry attempts to maintain its historical profit as a percent of sales, prices must be increased 1.04%. If the same return on total assets is to be maintained, a price increase of 1.16% is necessary.

(b) 1983 Standards (BPT)

Exhibit VII-4 also shows the total price increase necessary to meet 1983 water pollution control standards in terms of maintaining the current dollar level of profit, maintaining the historical profitability as a percent of sales, and maintaining the return on total assets. The required price increases are 1.94%, 2.13%, and 2.29%, respectively.

The maximum price increases based on maintaining the average industry return on total assets are shown in the following table.

Table VII-6

Projected Price Increases due to the Added Cost of Water Pollution Control

Type of Ferroalloy	Current Price (per Ton)	Projected Prices 1977 (per Ton)	Projected Prices 1983 (per Ton)
HC FeMn	$200.00	$202.32	$204.58
HC FeCr	311.00	314.61	318.12
SiMn	210.00	212.44	214.81
FeSi-50%	175.00	177.03	179.01

Source: A. T. Kearney, Inc.

The data in this table confirm that the price increases would be smaller than historical fluctuations in prices due to changing market conditions.

SECONDARY PRICE EFFECTS

In Section II it was mentioned that the primary markets for ferroalloys are the iron, steel and foundry industries. This is confirmed by data presented in Exhibit VII-6 and summarized in the following table.

Table VII-7

Use of Selected Ferroalloys

Type	Steel	Cast Iron	All Other	Total
FeMn	94.0%	2.2%	3.8%	100.0%
SiMn	90.3	2.9	6.8	100.0
FeSi	42.6	44.4	13.0	100.0
FeCr	88.7	2.5	8.8	100.0

Source: Exhibit VII-6

This table clearly shows that the steel industry is the primary user of ferroalloys, although use of ferrosilicon is split between steel and cast iron.

The effect that ferroalloy price increases will have on steel prices, if the increases shown in Exhibit VII-4 are passed on to steel users, is shown in Exhibit VII-7. This exhibit shows that the average price of steel per ton is approximately $203, based on current prices. It is further estimated that the current value of ferroalloys per ton of steel averages $2.62, or approximately 24 gross pounds of ferroalloys. An increase of 1.16% in the price of ferroalloys raises the cost of steel by $0.03 per net ton. An increase of 2.29% raises the cost of steel by $0.06.

To maintain the existing level of before-tax profits, the steel producer must raise his price by $0.03 and $0.06, respectively, in 1977 and 1983. This is an increase of less than 0.03% of existing prices.

The average automobile contains approximately 3,600 pounds of steel. The average increase in cost per car to an automobile manufacturer would be about 5.4¢ in 1977 and 10.8¢ in 1983.

It can be concluded that the secondary price impact will be minor.

FINANCIAL EFFECTS

(a) Profitability

Exhibit VII-8 provides an analysis of the projected impact that water pollution control costs are expected to have on industry profitability. Since insufficient data were available regarding the profitability of ferroalloys for individual companies, each group was assumed, initially, to be equally profitable as a percent of sales. However, investment and operating costs were adjusted to reflect the differences between those companies which are currently operating cooling towers and those which are not.

Table VII-8, summarized from Exhibit VII-8, shows the impact on profitability if all costs are absorbed without increasing prices. This table shows that:

1. The average industry return on sales is projected to decline from the current 9.12% to 8.19% in 1977 and 7.20% in 1983.

2. The average return on total assets is projected to decline from 9.59% to 8.42% and 7.29%, respectively, in 1977 and 1983.

3. The four companies which currently have some wet-type air pollution control systems in operation will be affected the most. The return on sales for these companies, as a group, is expected to decline from 9.17% to 6.59% by 1983. This represents a drop of 28%. The return on total assets will decline 32% from 9.67% to 6.58%.

4. The average of the five companies with no wet-type air pollution control systems is expected to show a decline of 6% in both the return on sales and the return on total assets.

Table VII-8

Effects of Water Pollution Control Costs on Profitability - No Increase in Prices

	Use of Wet Air Pollution Control Systems		Total Industry
	None	Some	
Number of Firms	5	4	9
Percent of Total Industry Sales	32%	68%	100%
Profit (before taxes) as a Percent of Sales:			
Current	9.04%	9.17%	9.12%
1977	9.04	7.79	8.19
1983	8.52	6.59	7.20
Profit (before taxes) as a Percent of Total Assets:			
Current	9.46%	9.67%	9.59%
1977	9.46	7.94	8.42
1983	8.88	6.58	7.29

Source: Exhibit VII-8

Table VII-9 summarizes the pro forma profitability of the industry if prices are increased an amount equivalent to maintaining the current industry average return on total assets, 9.59%.

Table VII-9

Effect of Water Pollution Control Costs on Industry Profitability - with Price Increases

	Use of Wet Air Pollution Control Systems		
	None	Some	Total Industry
Number of Firms	5	4	9
Percent of Total Industry Sales	32%	68%	100%
Profit (before taxes) as a Percent of Sales:			
Current	9.04%	9.17%	9.12%
1977	10.10	8.83	9.23
1983	10.57	8.66	9.27
Profit (before taxes) as a Percent of Total Assets:			
Current	9.46%	9.67%	9.59%
1977	10.71	9.10	9.60
1983	11.27	8.86	9.60

Source: A. T. Kearney, Inc.

This table shows that the profitability, measured as a return on sales, of the industry as a whole is projected to show a slight increase, from 9.12% to 9.27%. However, the group of companies using some wet air pollution control systems is still projected to show a decline in profitability. The return on sales will decline 5.6% and the return on total assets, 8.4%.

(b) Capital Availability

Exhibit VII-8 also shows the additional investment required. For meeting 1977 standards, the industry must spend $9.5 million. An additional $6.2 million is required to meet the 1983 requirements. The total of $15.7 million required for the industry is 3.9% of the current estimated industry assets of $404 million. The four companies which are affected the most require an estimated increase in assets of 5.5%, or $15.1 million.

These latter companies are broadly diversified, so that this $15.1 million in additional assets employed in ferroalloys manufacturing is quite small when compared to their total corporate assets.

PRODUCTION, EMPLOYMENT AND COMMUNITY EFFECTS

Based on the data analyzed and interviews with ferroalloy manufacturers, it is believed that the proposed water pollution control standards will have no significant effect on production levels or plant closing. Thus, there will be little effect on industry employment and no impact on local communities due to plant closings.

It must be remembered that this industry is under economic pressure due to several other factors:

1. Air Pollution Control Costs. Annual air pollution control costs, preliminarily, are estimated to range from

two to five times more than the cost of water pollution control. The air pollution problem is of much greater concern to the industry than water pollution control.

2. Imports. Imports have increased considerably in recent years. Ferromanganese imports amounted to 26% of consumption in 1971 and nearly 40% in 1972. Ferrochromium imports also were high, accounting for over 44% of consumption in 1972.

The result has been a severe profit squeeze for the industry, since foreign-produced ferroalloys have been delivered at lower prices than domestically-produced ferroalloys. There is some indication in 1973 that this price differential has been narrowed.

3. Industry Cycles. The cyclical nature of the steel industry in the United States greatly affects the demand for ferroalloys. Since there is little product differentiation, competition is keen during low periods of the cycle.

The U.S. ferroalloys industry has exhibited very little growth during the past five years. Bureau of Mines data show the following total shipments of all ferroalloys since 1967:

Year	All Ferroalloy Shipments (Millions of Gross Tons)
1967	2.5
1968	2.4
1969	2.6
1970	2.5
1971	2.3
1972	2.4
1973	2.8

Source: Minerals Yearbook

In addition, industry sources have indicated that total furnace capacity of the industry has remained at a constant level. Any new furnace installations have generally been to replace existing capacity.

For the four ferroalloys covered by this study, there are currently 9 manufacturers operating 22 plants. Of this total, two plants are converting to the production of silicon metal.

Two plant closings have been announced for 1973, although the current high level of demand for ferroalloys may keep these open for another year. There is a likelihood that three additional plants may close because of a combination of financial problems, air pollution control costs, and other factors.

In total, by 1983, it is our opinion that the producers of the 4 ferroalloys covered by this study may consist of 8 companies operating a total of 15 plants. The reduction from the present level of 22 plants is not expected to have been a result of added water pollution control costs.

NEW SOURCE STANDARDS

While new source standard costs are the same as those for the 1983 standards, it is difficult to evaluate what impact these standards will impose on this industry. Some of the reasons for this are:

1. Industry furnace capacity has not grown in recent years. About two new furnaces have been installed each year as

replacements for existing furnaces. It is possible to install a new furnace without adding any major costs for water pollution control, so the effect may be zero.

2. If an existing furnace with a wet scrubber system is replaced by a new furnace with a dry baghouse system, the annual costs would be reduced by $599,000 for 50 megawatts of capacity.

3. The replacement of a dry system with a wet system would add about $599,000 in annual costs, based on the conversion of 50 megawatts of furnace capacity.

No data were available regarding furnaces which are candidates for replacement. Because of this, it was assumed that the new source standards would have very little, if any, impact on industry profitability, industry growth, or balance of payments.

EXHIBIT VII-1

ENVIRONMENTAL PROTECTION AGENCY

COST OF WASTEWATER TREATMENT - 1977 REQUIREMENTS (BAT) FERROALLOYS INDUSTRY

Type of Furnace and Air Pollution Control System	Investment (Dollars per Mw)	Ownership and Operating Cost in Dollars per Mw-Day				
		Capital	Depreciation	Power	Other Operating	Total
Open Furnaces with Wet Air Pollution Control Devices						
Air Pollution Water Treatment	$17,143	$2.48	$3.30	$0.29	$14.54	$20.61
Furnace Cooling Water Treatment	1,266	0.17	0.23	0	0	0.40
Total	$18,409	$2.65	$3.53	$0.29	$14.54	$21.01
Closed Furnaces with Wet Air Pollution Control Devices						
Air Pollution Water Treatment	$22,222	$3.21	$4.27	$0.38	$18.85	$26.71
Furnace Cooling Water Treatment	1,266	0.17	0.23	0	0	0.40
Total	$23,488	$3.38	$4.50	$0.38	$18.85	$27.11
Open or Closed Furnaces with Dry Air Pollution Control Devices						
Furnace Cooling Water Treatment	$1,266	$0.17	$0.23	$0	$0	$0.40

Source: Effluent Limitations Guidelines and Standards of Performance - Ferroalloys Industry, Datagraphics, Inc., June, 1973.

EXHIBIT VII-2

ENVIRONMENTAL PROTECTION AGENCY

COST OF WASTEWATER TREATMENT - 1983 REQUIREMENTS (BPT) FERROALLOYS INDUSTRY

Type of Furnace and Air Pollution Control System	Investment (Dollars per Mw)	Ownership and Operating Cost in Dollars per Mw-Day				
		Capital	Depreciation	Power	Other Operating	Total
Open Furnaces with Wet Air Pollution Control Devices						
Air Pollution Water Treatment	$21,063	$3.05	$4.05	$0.36	$17.87	$25.33
Furnace Cooling Water Treatment	8,444	1.17	1.56	1.06	8.50	12.29
Total	$29,507	$4.22	$5.61	$1.42	$26.37	$37.62
Closed Furnaces with Wet Air Pollution Control Devices						
Air Pollution Water Treatment	$27,303	$3.95	$5.25	$0.46	$23.16	$32.82
Furnace Cooling Water Treatment	8,444	1.17	1.56	1.06	8.50	12.29
Total	$35,747	$5.12	$6.81	$1.52	$31.66	$45.11
Open or Closed Furnaces with Dry Air Pollution Control Devices						
Furnace Cooling Water Treatment	$ 8,444	$1.17	$1.56	$1.06	$8.50	$12.29

Source: Effluent Limitations Guidelines and Standards of Performance - Ferroalloys Industry, Datagraphics, Inc., June, 1973.

EXHIBIT VII-3

ENVIRONMENTAL PROTECTION AGENCY

COST OF WASTEWATER TREATMENT - NEW SOURCE REQUIREMENTS FERROALLOYS INDUSTRY

Type of Furnace and Air Pollution Control System	Investment (Dollars per Mw)	Ownership and Operating Cost in Dollars per Mw-Day				
		Capital	Depreciation	Power	Other Operating	Total
Closed Furnaces with Wet Air Pollution Control Devices						
Air Pollution Water Treatment	$27,303	$3.95	$5.25	$0.46	$23.16	$32.82
Furnace Cooling Water Treatment	8,444	1.17	1.56	1.06	8.50	12.29
Total	$35,747	$5.12	$6.81	$1.52	$31.66	$45.11
Open or Closed Furnaces with Dry Air Pollution Control Devices						
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Source: Effluent Limitations Guidelines and Standards of Performance - Ferroalloys Industry, Datagraphics, Inc., June, 1973.

EXHIBIT VII-4

ENVIRONMENTAL PROTECTION AGENCY

EFFECT OF WATER POLLUTION CONTROL COSTS ON PRICES

Standards	Additional Annual Industry Cost (000)	Total Industry Price Increase Versus Current Prices	
		Dollars	Percent of Sales
1977 Requirements (BAT)			
Maintain Same Actual Dollar Earnings, before Taxes	$4,034	$4,034	0.95%
Maintain Same Earnings as a Percent of Sales, before Taxes	4,034	4,439	1.04
Maintain Same Earnings as a Percent of Total Assets, before Taxes	4,034	4,928	1.16
1983 Requirements (BPT)			
Maintain Same Actual Dollar Earnings, before Taxes	$8,226	$8,226	1.94%
Maintain Same Earnings as a Percent of Sales, before Taxes	8,226	9,051	2.13
Maintain Same Earnings as a Percent of Total Assets, before Taxes	8,226	9,718	2.29

Sources: Tables VII-3, VII-4 and VII-5 and Exhibit VII-5.

EXHIBIT VII-5

ENVIRONMENTAL PROTECTION AGENCY

ESTIMATED PRO FORMA INDUSTRY PROFITABILITY

Sales (000)	$425,000
Profits before Taxes (000)	$ 38,760(1)
Total Assets (000)	$404,000(2)
Profit as a Percent of:	
Sales	9.12%
Total Assets	9.59%

Notes: (1) Profits are based on the reported industry average as stated by the Ferroalloys Association. The 1972 profits were not used as it was obviously a non-typical year. The 1967-1971 average profit after taxes was 4.56%. This is approximately 9.12% before taxes.

(2) The ratio of total assets to sales was estimated to be the same for the industry as for the combined data of three companies whose financial statements are published.

Sources: Field interviews, published data, and A. T. Kearney, Inc. estimates.

EXHIBIT VII-6

ENVIRONMENTAL PROTECTION AGENCY

FERROALLOYS CONSUMPTION BY END USE - 1972

Consumption of Selected Ferroalloys by End Use in Thousands of Short Tons, Gross Weight

		Steel									
Type	Total	Carbon	Stainless	Alloy	HSLA	Electric	Tool	Cast Iron	Super Alloys	Alloys	Other
Ferromanganese											
High Carbon(1)	823.8	659.9	4.2	76.7	59.4	0.3	1.2	16.2	0.2	4.6	1.0
Low and Medium Carbon	144.2	99.4	5.3	26.5	8.3	0.2	0.2	2.0	0.1	1.2	1.0
Total	968.0	759.3	9.5	103.2	67.7	0.5	1.4	18.2	0.3	5.8	2.0
Silicomanganese	124.3	71.1	8.4	26.7	6.5	0.8	-	3.7	W	2.4	4.7
Ferrosilicon											
-25%-55%	401.9	103.5	18.0	35.8	8.1	1.1	2.1	223.9	0.3	2.6	6.5
-56%-70%	24.7	10.5	0.3	1.5	W	W	W	11.8	W	W	0.6
-71%-80%	99.5	24.8	9.2	12.5	1.5	W	0.6	29.7	-	0.3	20.9
-81%-95%	19.4	1.2	0.2	1.3	W	W	W	7.2	W	8.8	0.7
Total	545.5	140.0	27.7	51.1	9.6	1.1	2.7	272.6	0.3	11.7	28.7
Ferrochromium											
Low Carbon	123.1	1.3	93.8	15.1	2.1	-	1.1	1.0	4.8	1.5	2.4
High Carbon	190.0	2.5	122.2	37.4	8.5	-	3.6	8.2	5.1	1.8	0.7
Ferrochromium-silicon	64.7	0.5	56.0	4.5	2.5	-	0.2	0.1	0.8	W	0.1
Other	13.0	W	0.2	3.5	2.6	-	W	0.7	1.8	2.6	1.6
Total	390.8	4.3	272.2	60.5	15.7	-	4.9	10.0	12.5	5.9	4.8

Notes: (1) Includes blast-furnace-produced ferromanganese.
(W) Withheld to avoid disclosure.

Source: 1972 Minerals Yearbook, preprints.

EXHIBIT VII-7

ENVIRONMENTAL PROTECTION AGENCY

IMPACT OF FERROALLOYS PRICE INCREASES ON STEEL PRICES

		Projected		Percent Increase Versus Current	
	Current	1977	1983	1977	1983
Average Price of Steel per Ton	\$203.00(1)	\$203.03	\$203.06	0.01%	0.03%
Average Value of Ferroalloys per Ton(2)	2.62	2.65	2.68	1.16	2.29
Estimated Average Profit(3) of Steel per Ton					
Dollars	8.61	8.61	8.61	0	0
Percent of Sales	4.24%(4)	4.24%	4.24%	0	0

Notes: (1) Based on the average of the following current quoted prices:

Cold Rolled Sheet	- \$201.50/ton
Cold Finished Bar	- 240.00/ton
Hot Rolled Carbon Bar	- 167.50/ton
Average	\$203.00/ton

(2) Based on A. T. Kearney estimates of 14 pounds FeMn, 3.3 pounds FeSi, 4.7 pounds FeCr, and 1.9 pounds SiMn per ton of steel.

(3) Before taxes.

(4) Average of 1970-1972 profit for the primary iron and steel industry.

Sources: Metalworking News and Quarterly Financial Reports for Manufacturing Corporations.

EXHIBIT VII-8

ENVIRONMENTAL PROTECTION AGENCY

EFFECT OF WATER POLLUTION CONTROL COSTS ON INDUSTRY PROFITABILITY

		Estimated Current Industry Position					Pro Forma 1977 Industry Position					Pro Forma 1983 Industry Position				
					Profit as a Percent of					Profit as a Percent of					Profit as a Percent of	
	Number of Companies(3)	Ferro-alloys Sales(1) (MM)	Ferro-alloys Assets (MM)	Profit before Taxes(2) (MM)	Sales	Total Assets	Ferro-alloys Sales(1) (MM)	Ferro-alloys Assets (MM)	Profit before Taxes (MM)	Sales	Total Assets	Ferro-alloys Sales(1) (MM)	Ferro-alloys Assets (MM)	Profit before Taxes (MM)	Sales	Total Assets
No Price Increase:																
Firms with No Wet-Type Air Pollution Control	5	$135.0	$128.9(4)	$12.2(4)	9.04%	9.46%	$135.0	$128.9	$12.2	9.04%	9.46%	$135.0	$129.5	$11.5	8.52%	8.88%
Firms with Some Wet-Type Air Pollution Control	4	290.0	275.1(4)	26.6(4)	9.17	9.67	290.0	284.6	22.6	7.79	7.94	290.0	290.2	19.1	6.59	6.58
Total	9	$425.0	$404.0	$38.8	9.12	9.59	$425.0	$413.5	$34.8	8.19	8.42	$425.0	$419.7	$30.6	7.20	7.29
Price Increase of 1.16% in 1977 and 2.29% in 1983																
Firms with No Wet-Type Air Pollution Control	5	$135.0	$128.9(4)	$12.2(4)	9.04	9.46%	$136.6	$128.9	$13.8	10.10%	10.71%	$138.1	$129.5	$14.6	10.57%	11.27%
Firms with Some Wet-Type Air Pollution Control	4	290.0	275.1(4)	26.6(4)	9.17	9.67	293.3	284.6	25.9	8.83	9.10	296.6	290.2	25.7	8.66	8.86
Total	9	$425.0	$404.0	$38.8	9.12	9.59	$429.9	$413.5	$39.7	9.23	9.60	$434.7	$419.7	$40.3	9.27	9.60

Notes:
(1) Based on estimated 1972 sales level.
(2) Based on the average industry profit for the 1967-1971 period as reported by the Ferroalloys Association.
(3) One company which has 100% of its capacity treated by a wet air pollution control system is included with "dry" group since it already has a water treatment system which meets the 1983 effluent requirements.
(4) These data were adjusted to reflect the difference from the industry average in costs between those companies operating cooling towers currently and those which are not.

VIII - LIMITS OF THE ANALYSIS

In this section the accuracy of the analysis and the major assumptions inherent in the conclusions are discussed.

ACCURACY

The accuracy of this study depends upon the accuracy of:

1. Published industry data.
2. Unpublished information supplied by knowledgeable industry personnel.
3. Cost data developed separately from this analysis by Datagraphics, Inc.
4. Estimates by A. T. Kearney consultants.

(a) Published Data

1. Production and Shipments. The published data provided by the U.S. Bureau of Mines and that collected from industry manufacturers by the Ferroalloys Association have some areas of conflict. In general, however, the data were felt to be sufficiently accurate to be used as an indicator of the relative size and growth of this industry.

2. Profitability. Little financial data were available regarding the profitability of ferroalloys for the nine companies analyzed. Therefore, much of the profitability data was calculated based on industry average data published by the Ferroalloys Association and A. T. Kearney, Inc. estimates. No financial data were available for individual plants.

(b) Unpublished Data and Information

All industry manufacturers were personally contacted to determine plant capacities, type of air and water pollution control facilities in existence, type of furnaces installed, operating data, and plans for future growth and development.

These data have been treated on a confidential basis and are assumed to be accurate. However, not all respondents would, or could, supply the desired information. Thus, some data had to be estimated to provide a complete analysis. The result is that total industry data are felt to be more accurate than data on individual plants.

(c) Cost Data

The cost data provided were used as supplied. No effort was made to audit these data, but the order of magnitude of costs seemed to be in line with industry expectations.

(d) A. T. Kearney, Inc. Estimates

Since some data were treated as proprietary by industry sources, or unavailable, it was occasionally necessary to estimate some industry data. Examples of such estimates are:

1. Sales by company.
2. Individual plant's shipments.
3. Assets employed in ferroalloys manufacturing.

While some of these data were not specifically published in the report, they were a necessary step in the analysis. They were not presented due to the confidentiality of the data.

CRITICAL ASSUMPTIONS

The assumptions which directly affect the findings and conclusions of this study are discussed in the following paragraphs.

(a) Industry Profitability

It was assumed that the industry's average profitability as a percent of sales would continue to be equal to the average for the 1967-1971 period. (See Exhibit VII-5.)

The assumption was based on the fact that the devalued U.S. dollar has narrowed the price gap between imported and U.S.-produced ferroalloys in 1973.

If imports can sustain lower price levels than domestically produced ferroalloys, the impact of water pollution control costs and air pollution controls costs will be much greater.

(b) Continued Use of Dry Air Pollution Control Systems

A second assumption bearing upon the impact of water pollution control costs on this industry is the continued trend to dry air pollution control systems.

Industry sources concur with this trend to dry systems, but pending air pollution control restrictions may have an effect on whether wet or dry systems are used.

If the one-third of the industry operating with no air pollution control devices adds wet air pollution control systems, the additional investment required to conform to 1983 standards would be over $9 million.

IMPACT ON INDIVIDUAL COMPANIES

Obviously the economic impact on individual companies will not be equal. With only nine industry manufacturers, however, it is impossible to discuss these cases without disclosing information which was obtained under promise of confidentiality.

Even a general discussion of these companies would reveal the identities to knowledgeable industry personnel. Therefore, no discussion which contained data gathered from confidential sources and could identify individual firms was presented in this report.